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Engineering News-Record

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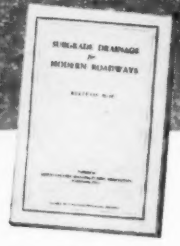
EXACTING BUSINESS.—Concreting the arch of a cut-and-cover conduit on the Colorado River Aqueduct under desert temperature conditions

THERE'S STILL TIME TO "Winter Proof" YOUR ROADS



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A MOMENT WITH THE PUBLISHERS

"Wrong Address"?

ENGINEERS generally have been interested in the recent exchange of views between President Roosevelt and Dr. Karl T. Compton and other technical educators. The President very properly pointed out the need for education that will "give coming generations of engineers the vision and flexible technical equipment" necessary to cope with the social implications of their technical progress.

That need is increasingly urgent. From time to time this page has noted it; for the most part, engineering educators are keenly alive to it. But Dr. Compton scores a bulls-eye when he asks President Roosevelt why his exhortation should be directed specifically to the engineers when, as he puts it, "similar breadth of knowledge and training is also urgently desirable among business leaders, economists and politicians."

After all, the technician's primary responsibility has been to help man conquer his physical environment. Society has asked him to seek out and harness the powers of nature, to extract and process her material resources and to contrive those works and facilities that enable man to expend his energies with greater return to himself. Generally speaking, society has kept him pretty consistently within that specialized sphere and it is a matter of universal recognition how splendidly he has wrought to create and produce in ever increasing abundance those material goods and services that make for higher standards of physical well-being.

DESPITE all this, however, many leap to the conclusion that because his instruments of abundance are fumbled and misused, the technical man must be at fault. Nothing could be farther from the truth.

The engineer achieves an ever more efficient production that lowers costs, thereby making possible through higher wages or lower prices a commensurate increase in purchasing power for more of the people; it is not the engineer who, through monopoly, arbitrary price-fixing or other short-sighted business practice, tries deliberately to frustrate the principles of competitive enterprise on which our present order is based.

The engineer labors to invest the capital of the people in works and facilities that will return greater values in service and earnings for all; it is not the engineer who creates a spurious "prosperity" by printing reams of ghost securities to be bought by the public with ghost money in a whipped-up frenzy of speculation.

The engineer works on the assumption that what we have to share must be measured by the output of those who labor with adequate equipment under competent direction, and that when we undermine or destroy the will or capacity of men to work by withholding incentive or skilful management, we have ripped out the mainspring of the economic and social machine; it is not the engineer who encourages the people to believe that, whether they work or not, the community owes them a living and that somehow they will be privileged to share by law in more than they have produced by labor.

The "unemployment, bankruptcies and relief" that distress the President do not result, as he implies, from the impact of science and engineering. On the contrary, they result from the conduct of short-sighted business, speculative finance and vote-serving politics. Our trouble is not too much science among the technical men, it is too little science elsewhere. If the practitioners of industrial economics, of corporation finance and of politics were to serve society one-half as efficiently and faithfully as do the scientists and engineers, the net effect of the technological impact would be to drive mankind much more rapidly and consistently along the road toward a more abundant living.

IF the President's appeal to the engineering educators means that he favors an extension of the engineer's influence into these other fields and that he would have him prepare for the greater responsibilities thereby incurred, he will have the hearty endorsement of the rank and file of the profession. But if he implies that some deficiency in the engineer's social sense is responsible in any degree for our social and economic failures, Dr. Compton's intimation of a misdirected appeal is quite in order.

Willard Chevalier

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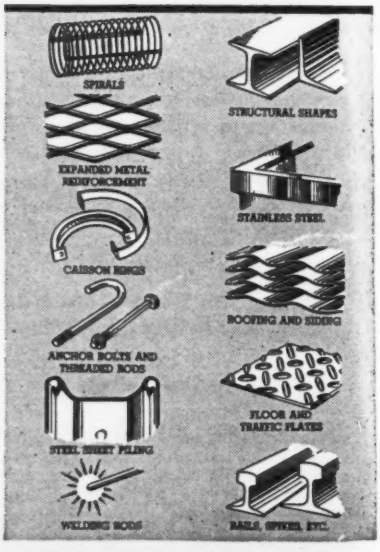

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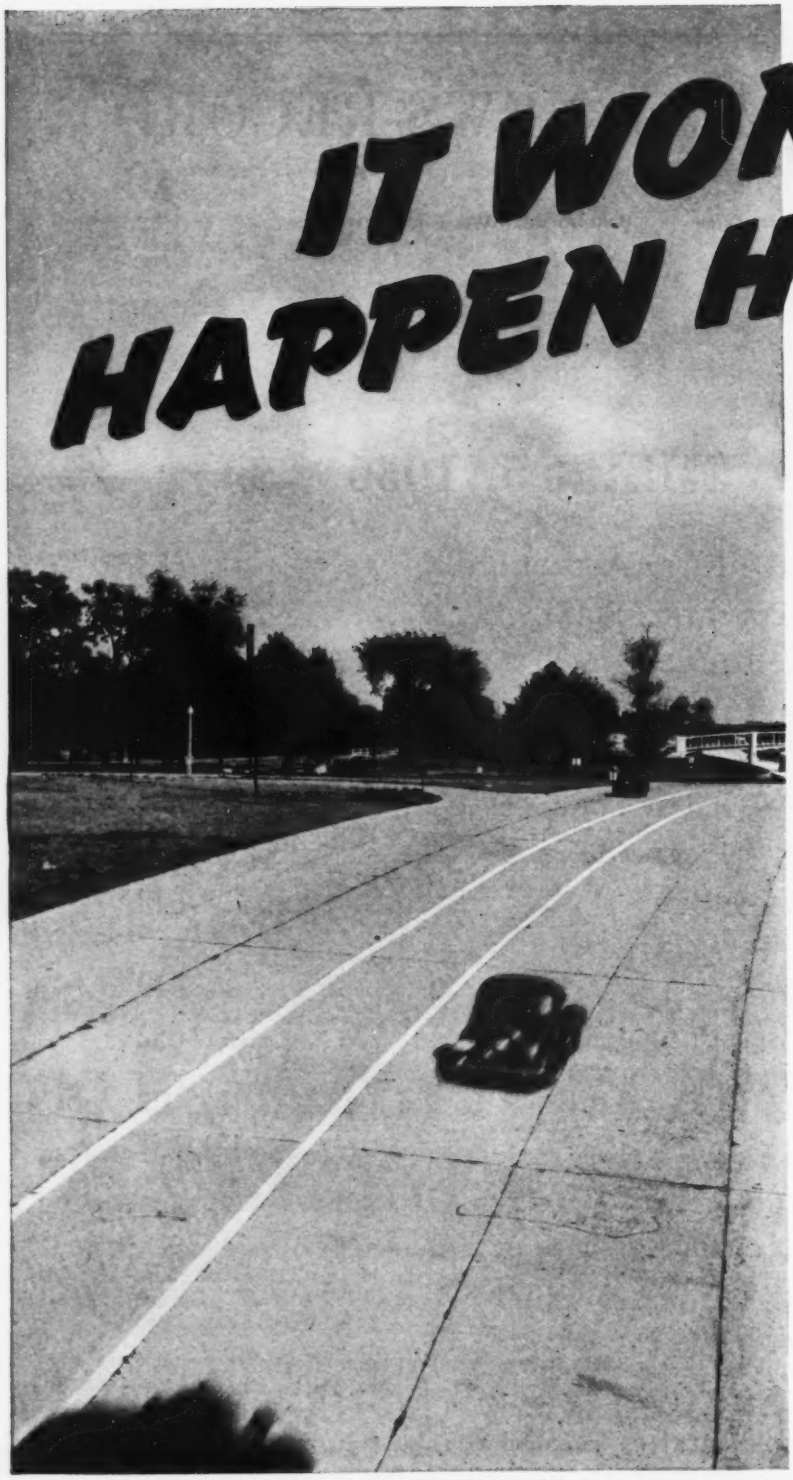
■

Hingeless steel arches are rare enough that their erection procedures are always instructive. The 800-ft. span of the Henry Hudson Bridge in New York is the longest arch of this type yet built, which enhances its interest. Next week's feature article will describe the erection of this new structure which will soon be opened to traffic.

IT WON'T HAPPEN HERE!



Safety Markers of Atlas White Portland Cement on Super-Highway through Forest Park, St. Louis, Mo. Constructed by Webb-Boone Paving Company, St. Louis, under plans and specifications prepared by Missouri State Highway Commission.

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ATLAS WHITE PORTLAND CEMENT FOR TRAFFIC MARKERS

ENGINEERING NEWS-RECORD

November 5, 1936

FIG. 1—CONDUIT INVERT is poured and screeded to shape from a traveling platform receiving concrete through a chute. Finishing is done by hand from light platform in foreground.

Achieving Strength and Tightness in Cut-and-Cover Conduit

Design of 1,605-sec-ft. conduits of the Colorado River Aqueduct checked by test section—Serious problem of cracking met by whitewashing exterior, water spraying interior and by symmetrical backfilling

By D. B. Gumensky
Engineer, Metropolitan Water District of Southern California

NOW THAT more than half of the cut-and-cover conduit has been completed on the Colorado River Aqueduct, which is being built by the Metropolitan Water District of Southern California, there is opportunity to observe the results of the design features worked out to meet the unusual conditions of this job. Extremely high desert temperatures and wide variations in the materials traversed set exacting requirements on the design of a conduit large enough to convey 1,605 sec.-ft. In the following are set forth some of the features believed to be contributing factors in the good results thus far attained.

In the total 54 miles of cut-and-cover conduit 30 miles had been completed by Oct. 1, 1936, and the remaining 24 miles are to be completed before May 31, 1938. The 54-mile total will involve some 11,000,000 cu. yd. of excavation and 1,210,000 cu. yd. of concrete, at a total estimated cost of $16,375,000. The extent and the location of these parts of the aqueduct have been described in previous issues of *Engineering News-Record* as follows: June 16, 1932, p. 847; May 25, 1933, p. 678, and July 26, 1934, p. 97.

The conduit is located mostly through a country considerably cut up by water channels, where the problems of cross drainage require particular attention. Much of the cross drainage is conducted over the conduit in natural water channels without any special provisions, but the large water courses and depressions require the construction of inverted siphons.

The conduit barrel is of a type which proved itself in many other aqueducts—Catskill, Wachusett, Winnipeg and others. In Fig. 4 are shown typical sections used in earth and rock excavation. The standard section for earth cut is of plain concrete and consists of the upper arch and invert, which sometimes functions as an inverted arch. The arch is proportioned to resist the external loads imposed upon it. Its abutments are flared out to provide a sufficient bearing area and to keep the thrust line within the middle third of the section under varying conditions of loading. On firm and unyielding foundations the invert acts merely as a strut or a tie and needs no reinforcement.

Where the material under the structure is of yielding character, particularly in clayey soils, the foundation under the abutments yields and a part of the function of supporting the structure then has to be performed by the invert, which usually would crack unless it were reinforced. Two types of reinforced section are provided for such conditions; one treated as a complete

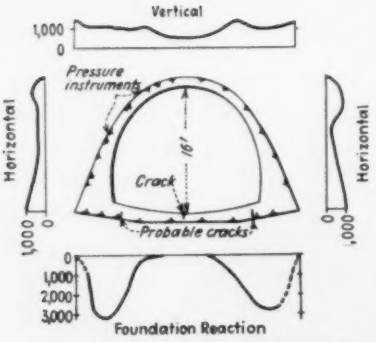


FIG. 2—OBSERVED PRESSURES ON CONDUIT under average cover of backfill 5 ft. above crown. Intensity in lb. per sq.ft.

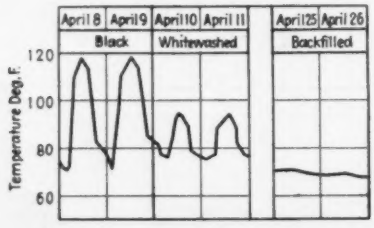


FIG. 3—CONCRETE TEMPERATURES in exposed concrete show fluctuations which are effectively reduced by a coat of whitewash and almost eliminated by 5 ft. of backfill.

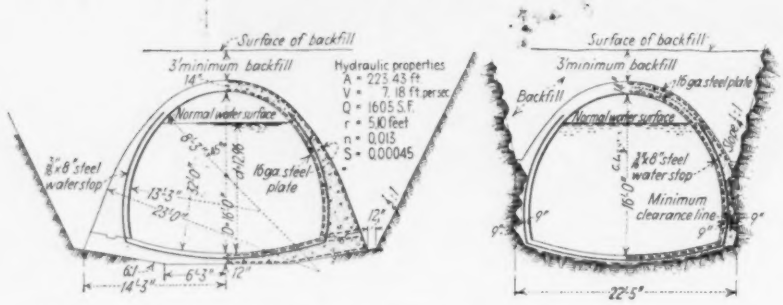


FIG. 4—TYPICAL SECTIONS OF CONDUIT. Construction joint shown on left half of each section—right half shows dummy joint. Water-stop extends around wetted perimeter to 1 ft. above water surface.

elastic ring with reinforcement throughout the section, and one designed as a combination of an unreinforced concrete arch and heavily reinforced supporting invert. In solid rock the flaring of the abutments is not necessary, and a considerable saving in excavation and concrete is effected by the use of a section shown on the right of Fig. 4.

The size of the structure was determined from economy considerations, balancing the initial cost of construction against the capitalized cost of operation and maintenance. The underlying mathematical and economic principles have previously been discussed in connection with the principles of siphon design. (*ENR* June 27, 1935, p. 899.)

In order to prevent transverse cracking from low temperatures and shrinkage, transverse joints are provided every 35 ft. along the conduit. The construction joints at the ends of the separate pours are plain butt joints made watertight by a 3/16 x 8-in. steel water-stop painted with coal tar and extending 1 ft. higher than the normal water surface. Joints falling between construction joints are of dummy type and are formed by inserting a 16-ga. sheet-steel diaphragm painted with tar into the form. This sheet remains permanently in the concrete and provides a plane of weakness. Steel waterstops are provided, as at the construction joint.

On the longer reaches of conduit special means of access are provided. Rectangular 3 x 10-ft. openings in the crown of the arch are spaced 2,000 ft. apart, and in addition there are 16 x 24-ft. openings at the ends of siphons and in places where the length of the conduit without means of access by truck is greater than 4 miles. A light storage-battery truck can be lowered readily through the large openings to provide quick transportation for men and materials incidental to inspection, maintenance or repairs.

Design checked by test section

A full-size section of cut-and-cover conduit 700 ft. long, now a permanent part of the aqueduct, was built by the district forces prior to the general issue of specifications. This section, at the west end of Fan Hill Siphon, was built to test the adequacy of the plans and the specifications and in order to verify the validity of the design assumptions such as to distribution of external loads, foundation reaction, effect of temperature variation, effect of various methods of curing, and minor features.

From observation of various pressure cells placed around the arch and under the invert it was found that the greater part of the invert reactions was concentrated under the arch abutments, but that the resultant for each side was located nearer the center of the invert than has been assumed. This was caused by settlement of the invert under arch abutment loads. Measured arch pressures showed unequal distribution especially where the backfill was packed by equipment running over it. In Fig. 2 are shown the observed pressures on the test section. The general agreement with the design assumptions was found to be sufficiently close to warrant no changes in form or proportioning of the conduit.

Observation of temperatures in the setting concrete showed that the maximum was reached within 30 hr. after pouring and that the heat of hydration was largely dissipated in three days after pouring. The temperatures in the concrete during the setting period were found to depend on the average daily temperature at the time of pour and on the temperature of the wet concrete as poured. The maximum temperature in the concrete during hydration reached 45 deg. F. above the temperature of wet concrete when poured. In structures exposed to the sun the maximum daily variation in temperature was 50 deg. F. at the surface. The difference in temperature of concrete on inside and outside faces of the conduit reached 40 deg. F. This temperature difference produced tensile stresses reaching 200 lb. per sq. in., which caused cracks. An application of a whitewash coating on the outside, over the coat of curing compound, reduced the variation by more than half. Backfilling practically eliminated the daily temperature variation.

Fig. 3 shows typical phases of temperature variation for the top of conduit. This variation is less pronounced in the lower parts of the structure.

The stresses in the concrete were determined either from measurement of strains in various sections of the conduit, or from the measured changes in shape under various conditions of loading. It was found that under ordinary conditions of loading compression stresses in all parts of the structure were of low intensity, not over 350 lb. per sq. in. Tension stresses caused by shrinkage, changes in temperature, and settlement of foundation were relieved by cracking. Uneven backfilling of the structure from one side only caused large unsymmetrical cracks and might cause a collapse of the structure if continued for an appreciable length of the conduit.

Control during construction

Trenches for the conduit are excavated by dragline. No trimming is required for the sides of the trenches. Preparation of subgrade for the invert requires a constant watchfulness on the part of men in charge. Even in well-cemented sand and gravel, such as is common along the desert location, it was often found necessary to sprinkle and roll the subgrade in order to get sufficient compaction of the foundation. Where the material showed any lack of compaction the subgrade was sprinkled

and rolled throughout its entire length. Particular care was taken in compacting the fill in overexcavated sections of the subgrade.

The invert is poured on moistened subgrade. The concrete usually is machine-placed from a traveling placing platform and a slip form which vibrates and screeds the invert concrete into final shape. The surface is hand finished by troweling from a light platform following the placing machine. Before the concrete is entirely set the portions of invert upon which the arch abutments are to rest are thoroughly cleaned, usually by air and water jets, and then covered by wet burlap until ready to receive the arch pour. The arch usually is poured in sections 70 ft. long in one continuous operation. In order to obtain a good bond between abutment and arch, a thin coat of cement grout is applied to the joint before pouring the arch. As a check on the condition of construction joints and on the quality of concrete, 6-in. test cores are drilled out of the completed structure at various points, usually from two to six months after completion of the pour.

The outside forms are removed several hours after the concrete has set, the interval depending mainly on local conditions—temperature and attained concrete strength. After stripping, exterior concrete surfaces are kept wet until the application of two coats of cutback coal-tar sealing compound. The sealing coats, followed by a dense coat of whitewash, are put on within a period beginning not earlier than two hours before sunset and ending not later than three hours after sunrise the morning following pouring. Inside forms are removed after a somewhat longer period of time.

Immediately after stripping the surfaces are inspected and any defects are repaired immediately. The interior of the conduit is cured for two weeks by a water spray or mist; meanwhile the ends of the section are closed by timber and canvas bulkheads to prevent escape of moisture. It was found that after the mist curing it was desireable to keep a small pool of water on the bottom of the invert to provide sufficient moisture in the air to prevent injurious drying out and cracking.

Backfilling follows the stripping within a few days, generally as soon as the concrete acquires sufficient strength to take the load. The usual procedure of backfilling is to push the excavated material into the trench with a bulldozer, bringing up the fill fairly evenly on the two sides of the structure.

As a precaution against the overstressing of the structure from the extreme desert heat no concrete was poured in the months of June, July, August and September.

Longitudinal cracks, most of them haircracks, were observed in some sections of the conduit near the center of the invert and in the upper portion of the arch. The cracks in the invert are traceable to the settlement of the foundation. The cracks in the arch appear to have been caused by shrinkage in setting, temperature changes, and possibly by springing of the interior steel forms during removal. Cracks in the top of the arch extending one to two feet back from the end of the pour occasionally developed during placing of the next run. This was thought to be due to a movement of the forms as they took the load of fresh concrete. The occurrence of such cracks has been prevented by avoiding a rigid connection between the inside forms ready for pour and the forms still in place on the preceding pour.

A movement takes place in both the inside and the outside forms during deposition and vibration of the concrete. The outside forms tend to spread laterally and hence to come down at the crown, the inside forms move inward laterally and rise at the top. Removal of the outside forms even after the concrete is set disturbs the equilibrium and tends to crack the arch by the lateral push of the inside forms trying to resume their normal shape. This tendency often can be prevented by loosening the bolts and spreaders of the inside forms before the outside forms are removed.

No transverse cracking of the conduit is observed in the completed sections of the structure, except at the dummy joints where water-stops are provided to insure watertightness. Here the movement averages about 0.05 in. The transverse construction joints show movement of about the same magnitude.

All engineering and construction of the Metropolitan Water District of Southern California are under the general direction of F. E. Weymouth, general manager and chief engineer; J. L. Burkholder, assistant general manager; and Julian Hinds, assistant chief engineer. W. C. Christopher, designing engineer, is in direct charge of design.

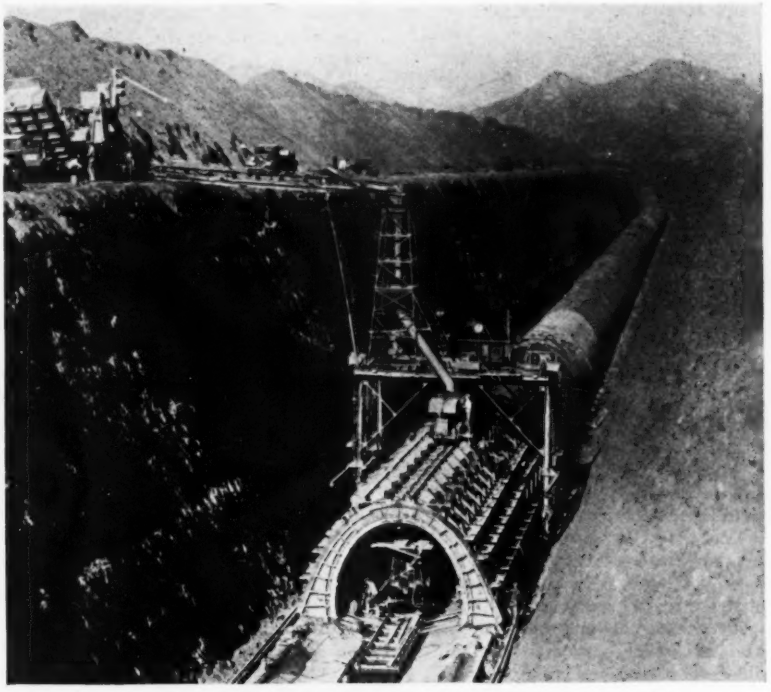


FIG. 5—POURING THE ARCH OF THE CONDUIT. From mixer on bank, by means of conveyor belt and chutes, concrete is delivered to a distributing car on top of the forms. Gantry is used for moving and setting forms.

Waterworks in Ohio Serve Five Million People

IN OHIO there are 380 separate waterworks installations supplying almost 5,000,000 people, or 75 per cent of the state's population, according to a paper by F. H. Waring, chief engineer of the Ohio state department of health, in a recent address at the Wisconsin section meeting of the American Water Works Association. About two-thirds of the population obtain their water from 80 plants utilizing surface sources of supply. Some 47 plants soften their supplies, 31 by the conventional lime and soda method and 16 with the zeolite process. Ohio leads all the states in softening water supplies, and is credited with the discovery at Columbus of the sterilizing effect of causticity when enough lime is used to affect the softening reaction.

Industrial Waste Pollution Surveyed

Data from 1,792 industrial establishments correlated with analyses on 401 representative kinds of wastes and results classified in terms of waste per employee per day in various types of industry in New Jersey.

INDUSTRIAL WASTE discharges in the streams and water courses of New Jersey are estimated to contribute a daily load of 1,192 tons of solids with an oxygen consuming value totaling 106 tons, according to a report by Dr. Willem Rudolfs, chief, New Jersey Sewage Experiment Station, presented at the meeting of the American Chemical Society on September 8, 1936. These findings were based on a survey covering 1,792 plants in various parts of the state, from which definite information and samples were obtained from 1,213 industries. Analyses were made on 401 representative types of wastes.

By assembling the data in classifications following the grouping used in the National Census of Industries, calculations were made to determine pollution by groups of industries, and the gross pollution caused by all industries in the state. Samples of waste from 205 different industries were selected for a special study to determine the volume and strength of the waste produced per employee per day.

Industries Highly Diversified

The problem of stream pollution in New Jersey is intensified on account of the density of population and industrial development. Fully two-thirds of the population resides in the northern part of the state, where manufacturing is of primary importance and greatly diversified. The dyeing and finishing of textiles, production of chemicals, silk manufacturing, tanning, steel works and power laundries are among those industries producing larger quantities of waste. Some of the wastes are highly putrescible, others are poisonous or contain large quantities of suspended solids, capable of settling to form sludge banks in the streams.

The survey, covering nine counties of the most highly industrialized areas of the state, was conducted with the aid of a number of chemists and engineers employed in projects sponsored by the CWA and ERA agencies. The water consumption of the industries from which samples were selected amounted to 54,600,000 gal. daily, while the liquid wastes discharged amounted to 43,651,000 gal. a day. The analysis on the samples included determination of different types of suspended solids, pH values, sludge volume, oxygen consumed, acidity, alkalinity, and chlorides.

Employee unit comparisons

In the accompanying table is shown a comprehensive summary of the results obtained, using an "employee unit" as a basis for comparison of industrial waste production. While these figures represent average conditions, it was carefully pointed out by Dr. Rudolfs that within a "type" industry considerable variations from the calculated weighted mean did occur.

As might be expected, the results indicate that daily solid production, oxygen demand, acidity and alkalinity of the waste per employee show wide variations in different industrial groups. The distillery industry is the outstanding contributor of wastes, with several times greater suspended, settleable and "colloidal" solids production and oxygen demand per employee a day than any other group.

On the basis of the sludge produced the groups of industries can be roughly divided into three parts: (1) those producing relatively small quantities of solids that will settle in streams (laundries, dairies, dye plants); (2) those producing medium quantities of settleable solids (organic and steel); (3) those producing relatively large amounts of solids (distilleries, tanneries, chemical). The bulkiness of the sludge is not the same, however, but the volume of sludge on a dry basis produced by the industries discharging medium and large quantities of sludge is similar.

Comparing the groups of industries on the basis of oxygen consumption, the organic waste groups (meat packing, rubber, wool, etc.) are comparable with the steel industry in producing a total waste per employee of low oxygen requirement. In the medium group are found laundry, tanning and chemical wastes; the waste of the dairy industry, in respect to oxygen demand, is comparable to that of the dye industry. These results are illuminating, because, although the group wastes contain greatly varying quantities of suspended solids and have differing oxygen requirements, on the basis of the "employee unit," the solids production and oxygen demands are in close accord. This is due, states Dr. Rudolfs, to the variation in volume of waste produced.

Total waste for state

From the 1930 census reports data were secured covering all industries of the state which fell into the types of industrial classification made for the survey. The wet waste produced by

AVERAGE POUNDS OF WASTE DAILY PER EMPLOYEE FOR EACH TYPE OF INDUSTRY

Analyses	Tannery	Chemical	Organic	Steel	Dye	Distillery	Dairy	Laundry	Average Without Distillery	Average Without Distillery or Dairy	Average
Total solids, lb.	15.81	27.73	2.95	28.80	12.48	92.3	13.05	12.28	13.29	13.33	16.48
Ash, total solids, %	60.66	7.58	43.99	63.84	49.31	22.71	40.86	.....	43.04	43.40	40.50
Suspended solids, lb.	1.92	1.18	0.39	0.62	0.87	29.16	0.92	3.61	1.07	1.10	1.61
Ash, suspended sol., %	42.51	50.51	28.95	50.52	24.50	16.08	33.88	22.96	36.27	36.67	33.75
Settleable solids, lb.	0.51	0.33	0.10	0.15	0.05	4.32	0.03	0.05	0.11	0.14	0.17
Ash, settleable sol., %	38.09	35.55	31.59	53.16	15.93	15.79	19.40	30.93	32.09	.....	30.06
Sludge volume, %	8.50	10.07	8.54	11.78	4.50	10.96	1.38	3.75	6.93	.....	7.44
Soluble solids, lb.	13.89	26.55	2.56	28.18	11.61	63.14	12.13	8.90	11.87	11.84	14.60
Colloidal solids,† lbs.	1.41	0.85	0.29	0.47	0.82	24.84	0.89	3.56	0.89	0.88	1.34
Oxygen consumed, lb.	1.73	1.53	0.20	0.25	3.00	31.89	3.03	1.55	1.09	0.92	1.67
Acidity* to P, lb.	40.5	43.5	12.0	140.5	31.0	225.0	12.5	34.0	32.5	38.4	41.5
to M. O., lb.	51.5	34.5	48.5	183.5	0.0	0.0	0.0	0.0	8.0	12.5	5.5
Alkalinity* to P, lb.	72.0	110.0	41.0	62.0	55.0	0.0	76.5	53.0	64.5	62.5	35.0
to M. O., lb.	81.0	107.0	31.0	43.0	81.5	135.0	103.0	108.0	72.5	68.0	77.5
Chlorides, lb.	1.91	1.46	0.10	0.31	8.50	0.58	0.94	1.07	0.96	0.96	0.90

* "Colloidal solids" include finely divided, pseudo colloidal and colloidal solids.
† Expressed as $CaCO_3$

the industries could be integrated, therefore, using as units the employees of the industries. The estimated total waste per day produced by all industrial groups for the entire state was reported as follows:

Total solids	1,192 tons
Suspended solids	98
Soluble solids	1,078
Settleable solids	13
"Colloidal" solids	82
Oxygen consumed	106
Chlorides	184
Wet sludge	264

Comparing the quantities of solids produced by the industries with the 900,000 tons of sewage solids discharged yearly into New Jersey streams, it was stated that the amount of suspended material produced by the industries, converted to the same density of sewage solids, appears to be well over 700,000 tons. Considerable portions of the finely divided solids, as well as the coarser settleable and the soluble solids, are capable of oxidation and exert a demand upon the oxygen resources of streams.

The estimated "population equivalent" of the industrial wastes, based on previously established standards of oxygen required to satisfy the average domestic waste demand per person per day, varies materially with the type of industry. For instance, the oxygen demand of the waste produced per employee by the tannery industry is stated to be 25 times greater than the oxygen demand of domestic sewage discharge per capita. The industrial group falling under the classification of "organic waste," on the other hand, requires only three times the oxygen per employee as the domestic sewage. In general, it was estimated that the "population equivalent" for all industry amounted to about 3,100,000; this represents about two-thirds of the total domestic sewage discharged by the entire population of the state.

Cellular Concrete Bridges Being Built in Washington

A NUMBER of cellular or hollow-member concrete bridges recently have been completed or are under construction in western Washington. Although of diverse types they have the common feature of main members of large over-all size hollowed out by internal forms which either may be removed or may be left in place, embedded in the concrete. Several of these bridges are of unprecedented long spans for this country, and the cost of those of the two-lane deck type has been extremely low. A tabulation of comparative data and a summary of the outstanding features of new bridges of this type are given in the accompanying table.

Among those listed the Buckley overpass is most notable for low cost. The $2.46 per sq.ft. of roadway surface is believed to be a low record for reinforced concrete structures of this type, with 40- to 60-ft. spans. The hollow construction is obtained by the use of internal forms, known as "banana crates," (Fig. 2) built up of wood and placed within the girder forms to save concrete and cut down the weight. These octagonal wooden shapes are made up of 1-in. boards internally braced to give ample strength for holding their shape while the concrete is being placed around them. In the Buckley bridge they remain within the girders permanently. To prevent risk of cracking the concrete by swelling, spaces are left at the corners between the wood boards of the sides of the crates to take up any swelling that occurs.

These crates are 2 ft. in diameter and 8 ft. long. They are placed in the girder forms with a 10-in. separation between them, thus providing transverse diaphragms in the girders at about 9-ft. intervals. Their use decreases the dead weight of the deck about 1,000 lb. per lin.ft. of bridge with corresponding decreases in total stresses, reinforcement, column and footing loads, etc.

CELLULAR TYPE REINFORCED CONCRETE BRIDGES IN WESTERN WASHINGTON

Name	Type	Longest Span (feet)	Total Length (feet)	Roadway Width (feet)	Overall Breadth (feet)	Contract Price (dollars)	Cost Per Lin.Ft. (dollars)
Schmitz Park†	Rigid Frame	175	250	54	69½	116,038	466.00
McMillin*	Through Truss	170	210	22	38	35,912	171.01
Purdy Spit	Continuous Girder	190	550	20	22	62,069	112.85
Eatonville‡	Rigid Frame	106	162	20	22	11,567	71.40
Buckley	Continuous Girder	60	223	20	22	10,949	49.10

†Designed for double track street car and *H* 20 loading; others for *H* 15 loading.
‡Contract price did not include removal of existing bridge, all others did.
*For details see *E N R.*, Jan. 2, 1936, pp. 1-4.

FIG. 1—THE BUCKLEY OVERPASS illustrating application of low-cost, hollow-type construction to a grade separation problem.

FIG. 2—OCTAGONAL WOODEN forms, known as "banana crates" are suspended in the center of girder forms to save unnecessary dead weight.

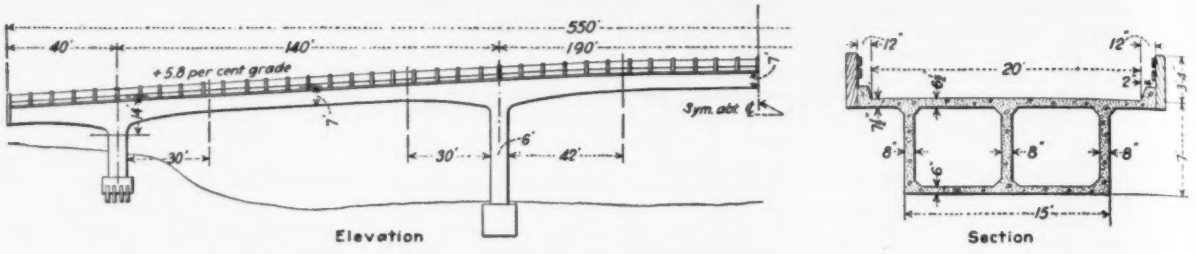


FIG. 3—LONG SPAN cellular-type bridge now under construction near Purdy, Wash.

The girders have a 4-ft. over-all width, a mid-span depth of 3 ft. and a maximum depth at the haunch of 5½ ft. There are two of these girders, spaced 7 ft. apart, and their outer sides are flush with the sides of the supporting columns (Fig. 1). This gives the supporting structure an over-all width of 15 ft. beneath the 20-ft. roadway.

The Eatonville bridge crosses the Mashel River south of Tacoma, Wash., where heavy floods sometimes occur. The outstanding feature of its design is a shallow-deck made possible by developing negative moments from cantilever spans at either end of the main 106-ft. span in conjunction with typical rigid frame pier moments. The cantilever approach spans made it possible to do away with abutments and wing walls and to provide a maximum waterway for a flashy stream. By the use of a wide box girder the thickness of the deck was kept down to 4 ft. at mid-span.

The cross-section of this structure consists simply of a two-cell, box girder 15 ft. wide, with an 8-in. central web, 8-in. side webs, and 8-in. transverse interior webs 20 ft. on centers. Bottoms and sides of the box girders were cast in the first pour, after which the roadway slab was placed as the second and final pour.

The Purdy Spit bridge (Fig. 3) is now under construction. Details of the McMillin bridge were published in *Engineering News-Record*, Jan. 2, 1936, p. 1. The Schmitz Park bridge will be described in a later issue.

Harbor Improvements at Dunkerque

Concrete jetties of both solid and trestle types enclose new tidal harbor having a lock opening into large basin connected with older docks. Landing facilities for English-French car-ferry line are of unusual design

ENLARGEMENT of the harbor at Dunkerque, France, and especially the provision of an improved and protected entrance, have been necessitated by the steadily increasing shipping business of the port. These requirements have been met by enclosing an area of open sea with jetties, to form an outer or tidal harbor, and constructing a large lock to connect this new harbor with a large new basin from which all the older basins or docks are accessible. The system of closed docks or floating basins is necessary owing to a daily tidal range of about 21 ft. New structures include a solid jetty of conventional type, a jetty of open or trestle type composed of precast concrete members, a large lock having cellular walls of steel sheet piling, and a pier for steamship accommodation in the tidal harbor. An unusual feature is a berth and landing stage for the steamers of an English-French railway car-ferry which began operation in October, 1936.

Wider harbor entrance

It will be seen from the plan, Fig. 1, that in the original layout of the port there was a long and narrow tidal harbor, having locks on its west side to give access to the enclosed docks. The former entrance to the harbor was a channel about 500 ft. wide and 1,640 ft. long, which was practically an extension of the tidal basin and was formed by two parallel jetties.

By the new works, a great triangular outer harbor (including the old entrance channel) is formed by a pair of jetties which coverge to an entrance opening 885 ft. wide, facing due north. This enclosed area has a maximum east-west width of about 5,000 ft. and a north-south length of 3,000 ft. It is of interest to note that this change from an entrance channel to a large artificial bay is, in principle, similar to that made by the U. S. Engineers in improving the harbors at Frankfort, Mich., and other ports on the east coast of Lake Michigan, as described in *Engineering News-Record* of June 18, 1931. Furthermore, the provision of additional water space by enclosing an area of open sea is somewhat similar to the method employed at Havre, France, as described in *Engineering News-Record* of May 24, 1934.

South of the broad base of the new outer harbor at Dunkerque is a strip of made land separating it from a new turning basin 4,000 ft. long and 900 to 1,200 ft. wide. The outer harbor and turning basin are connected by an entrance channel and lock 1,066 ft. long. Opening from the south side of the basin are a slip and pier and a special slip for tank steamers, this latter being adjacent to an oil storage plant and terminal. The basin is in connection with all the enclosed docks.

Jetty construction

Owing to local conditions, there is the unusual feature that the two jetties forming the outer harbor are of entirely different types. As to foundation conditions, the bed of the sea is of fine sand to a depth of some 80 to 90 ft., below which is compact clay continuing to a minimum depth of about 200 ft. below low water.

Solid-Type West Jetty.—As the main exposure is to the north and north-west, the west jetty is a massive solid concrete structure about 2,630 ft. long. Its superstructure, shown in Fig. 3, is 19 ft. wide at base and 14.7 ft. at top, this latter width including a 10-ft. walk on the harbor side and a parapet wall 5 ft. high on the sea side. The sides of the jetty are of precast concrete blocks laid up like masonry and serving as forms for the mass concrete filled between them. Blocks at intervals have projections on the rear side to bond or

key with the concrete core. For the first 820 ft. of its length this structure rests on a concrete base 21.3 ft. wide and 16.4 ft. deep, the concrete being filled between two rows of steel sheet piling 26 ft. deep and extending 10 ft. into the sand.

For the remainder of its length, the concrete superstructure is founded on a bed of loose rock. As the sea bed is of fine sand, the loss of this rock fill was prevented by covering the sand with a woven brush mattress 160 ft. wide, sunk in place by loading it with rock. On this mattress was deposited loose rubble stone of 200- to 2,700-lb. weight, to a height of 30 ft. and a top width of 30 ft., with slopes of 1 on 2 for the seaward side and 1 on 1½ for the harbor side. These slopes are protected against wave action by an 8-ft. blanket of rocks weighing 2,200 to 11,000 lb. In addition, the top and seaward slope of the rock fill are further covered by quarry blocks of 40 to 50 tons weight, upon which the concrete superstructure is built and to which it is anchored by dowels consisting of steel piles 6 ft. long, grouted into the spaces between the blocks. Expansion points are provided at intervals of 325 ft. in the jetty and 108 ft. in the parapet. The head of the jetty is in water nearly 30 ft. deep at low water.

Trestle-Type East Jetty.—Since the east jetty is on the sheltered side of the harbor, its superstructure is of the open construction shown in Fig. 2. It forms a 2,300-ft. extension of the old east jetty of the former entrance channel. Its foundation consists of a row of 39 hollow concrete caissons 23 ft. wide, 55 ft. long and 25 to 33 ft. deep, each having a working chamber 7.25 ft. high. These caissons were sunk till the tops were a little below the sea bed. Concrete filling of the caissons was continued upward above them as a concrete wall 20 ft. thick to 6.56 ft. above the sea bed, its top and sides being faced with reinforced-concrete blocks.

Upon this footing or foundation is the concrete trestle, with its deck 30 ft. above the base line or sea bed, forming a walk 9 ft. wide between railings. The bents or frames, 23 ft. high, are single precast concrete units, having posts 14-in. square and diagonals 12x14-in. They are spaced 12 ft. apart and are connected by longitudinal beams, with longitudinal diagonal bracing in each panel.

At the head of the jetty is a solid concrete pier, 55 ft. long and 25 ft. wide, with masonry walls and concrete fill, surmounted by the trestle. Upon this pier is a tower or lighthouse. Mooring posts are provided along the concrete footing, for use at low tide, ladders being placed at intervals on the trestle posts to give access to the lower deck of the trestle structure.

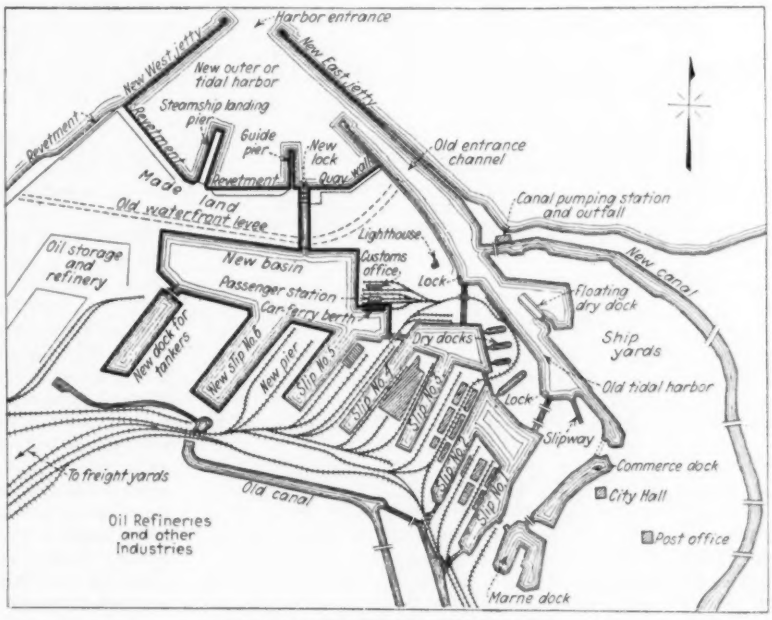


FIG. 1—NEW TIDAL HARBOR and dock with large piers are main features of harbor extension at Dunkerque, France.

The new lock connecting the outer harbor with the turning basin and the docks opening from it is 1,066 ft. long, with a lock chamber of 920 ft. available length. Rolling caissons forming the lock gates travel into chambers at right angles to the lock. At the inner end is a single gate, but the outer end has two gates, one of which is for reserve or emergency use. Culverts for filling and emptying the lock are fitted with stoney gates. The reinforced-concrete floor is 14.76 ft. thick, poured in alternate blocks or slabs 18x19 ft. A bascule bridge carries a single line of railway across the head of the lock.

An unusual detail of construction is that each wall of the lock chamber is formed by a double row of steel sheet piles of trough section, the piles being placed with their flanges in contact, thus forming a series of vertical cells. The piles are 70 ft. long, driven to 90 ft. below low water. A reinforced-concrete wall 4 ft. thick and 20 ft. high encloses the tops of the piles, every third pile being cut off 5 ft. below the others to form an irregular surface and give an effective bond for the concrete. The wall is finished with a granite coping.

Tie rods anchor the top of the concrete wall to a line of steel sheeting 10 ft. deep, while two lines of rods anchor the steel wall to another line of sheeting 20 ft. deep. It is to be noted that these anchorages are continuous lines of sheet piling, instead of rows of independent anchor piles. These tie-rods, 3 ft. apart, are secured to wales composed of pairs of steel channels on the rear of the lock wall and similar wales on the rear of the anchor sheeting.

Provision for the steamers of the new Dover-Dunkerque car-ferry service, started in 1936 by the Southern Railway (of England), is a novel detail of the facilities at this port. This car-ferry berth is at a corner of the turning basin, the cars being run on and off at the stern, while passengers enter and leave by a side gangway at the upper deck level, a ramp connecting with the customs offices and the railway station at the ground level. Its location is indicated on the map shown in Fig. 1.

Connection between the tracks on the ship's deck and those on shore is effected by a two-span through-truss bridge having two 90-ft. spans, as shown in Fig. 4. To adjust the outboard end of this landing to the varying level of the deck, the entire 180-ft. structure is raised and lowered as a unit, revolving around a bearing at the shore abutment. To permit of this operation, the bridge is suspended from portal trusses at the intermediate and outer bearings. Beneath the outer portal, each truss has attached to the top chord a sheave which lies in the bight of a cable having one end anchored to the overhead portal. From the sheave on the truss the cable passes up and over another sheave on the portal, beyond which its hanging end carries a counterweight. A separate cable and motor hoist provides for the operation of the landing bridge. Brackets on the bridge trusses ride in guides on the portal towers.

With the flexibiltiy of the cable suspension, the outboard end of the land-

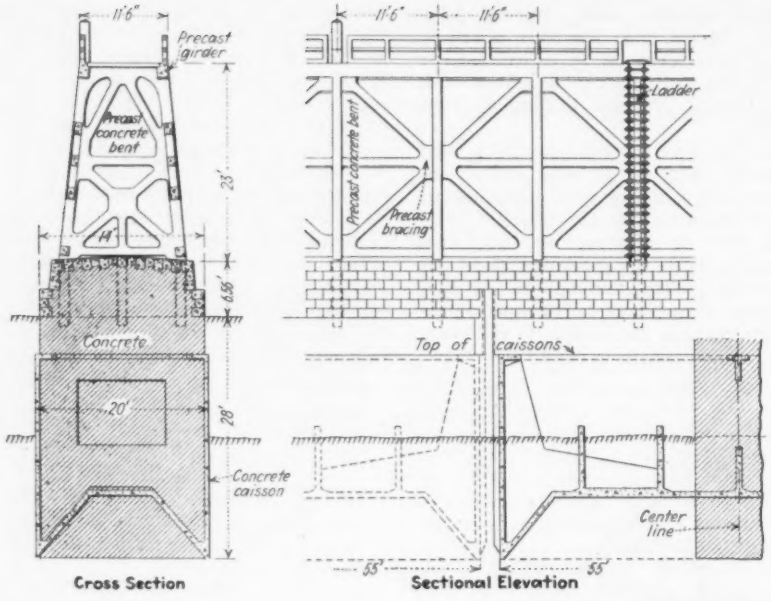


FIG. 2—TRESTLE composed of precast concrete members forms the east jetty enclosing the tidal harbor.

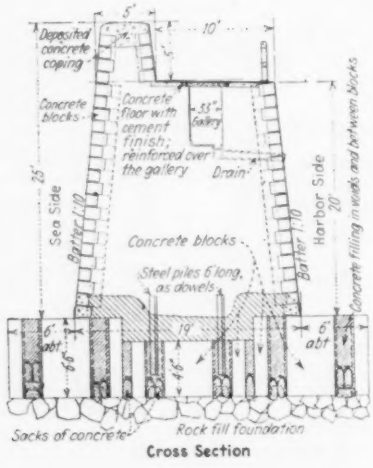
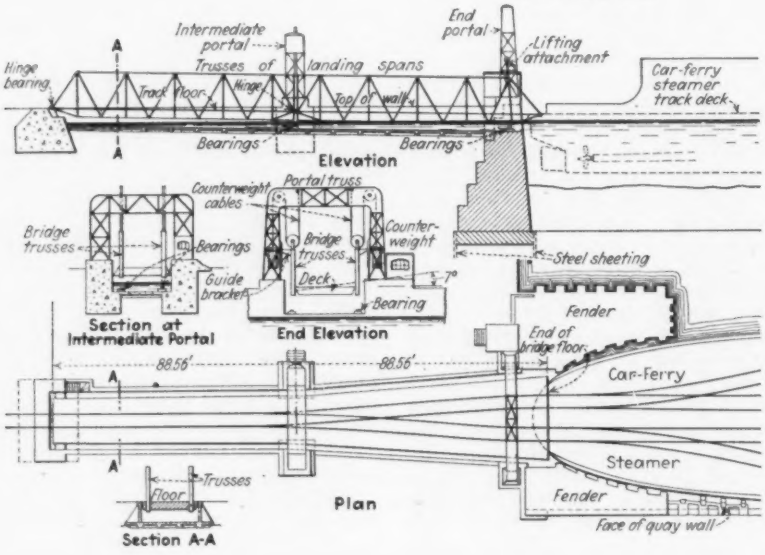


FIG. 3—SOLID CONCRETE construction is used for west jetty of tidal harbor enclosed from the sea.

FIG. 4—LANDING FACILITIES for sea-going car-ferry steamers of new French-English line.



ing can be tilted laterally to conform to any list of the ship due to unequal loading as the cars are moved on or off the deck. At the intermediate portal frame, the bridge trusses carry vertical rods which pass through guides in the overhead truss and thus hold the moving span in position during its vertical travel. The range of travel is about 12 ft. When lowered to connect with the ship's tracks, the outboard end of the landing rests upon the deck. A single track on the first span diverges to two tracks on the second span, to connect with the ship's tracks, as shown in Fig. 4, the width of the outboard end being thus about 33 ft. This landing bridge lies in a channel extending back from the basin, the outboard end of the landing projecting slightly beyond the quay wall. When fully lowered, the spans rest on bearings on the floor of the channel, as shown.

Miscellaneous features

The land side of the outer harbor is treated in two different ways. West of the lock it is dressed to a slope of 1 on 3 and covered with 6 in. of puddled clay and 6 in. of coarse gravel as the base for a revetment of reinforced-concrete slabs 4 in. thick. Concrete posts 6-in. square were driven at intervals of 6½ ft. in both directions. Between these posts were poured concrete ribs or beams extending up and down the slope, their reinforcement being tied to bars projecting from the posts. The concrete slabs, 6½ ft. long, rest on ledges formed on the beams. At the toe of the slope is a line of 10-ft. steel sheetpiles, backed by a concrete toe wall against which the bottom slabs are laid. The top of the revetment rests on another low wall, adjacent to which is a concrete walk. Similar revetment is provided for the seaward face of the made land, south of the west jetty, but in this case a parapet wall or wave break 3.28 ft. high is built along the top of the slope.

East of the entrance lock, a quay wall is built along the land side of the outer harbor. This wall is composed of steel sheetpiles 15.20 ft. deep, having along the top inside and outside wales of steel channels, forming a seat for a concrete coping. A similar line of waling is placed at the low-water line. At 46 ft. back from the wall are steel anchor piles, 14-ft. long, for two rows of tie-rods which extend to the wales on the sheeting. Rows of oak fender timbers are bolted to the water face of the steel quay wall.

Near the head of the lock is a guide pier extending 656 ft. from the quay wall into the harbor. This pier or jetty has walls of interlocking steel sheeting 6.22 ft. apart and 78 ft. deep, the top being about 12 ft. above high water. Sand is filled into about 3 ft. above high water, then a thick bed of concrete, upon which again is sand as the base for the floor or deck. Concrete copings

retain this deck, along the middle of which are posts or bollards for mooring ships waiting to enter the lock. Timber fendering protects the face of the pier.

To serve steamers which touch at the port but do not need to enter the docks, there is a pier 1,000 ft. long and 160 ft. wide, extending out from the south side of the outer harbor and having 33 ft. of water alongside at low water. This is a reinforced-concrete structure, carried by five rows of concrete cylinders sunk to 50 ft. below low water. These cylinders are 10 ft. in diameter, belled out to 16 ft. at the bottom.

Much of the surrounding country is below sea level and is protected by coast levees or dikes and is served by an outfall canal that formerly discharged into the old entrance channel of the harbor both the internal drainage waters and water from a number of small canals of the inland navigation system of France. That part of the outfall canal that traversed the site of the new turning basin had to be abandoned. A new canal was built around the east side of the harbor with a pumping station and regulating gates at the mouth.

All these extensive works and improvements were designed and carried out under the direction of M. Broquaire, chief engineer and director of the ports of Dunkerque and Gravelines.

Hydrologic Data Collection Recommended by Water Committee

Establishment of more adequate facilities for observing and recording data would remedy current deficiencies in knowledge of water behavior which in part are responsible for dam failures

A CERTAIN flood control project built in southern California was originally designed, after engineering investigation making use of such records as existed, to carry a maximum flow of 7,000 sec.-ft. It was fortunate that recording gaging stations were installed before construction started and happened to catch a flow of unlooked for volume, for, as a result of these observations, the original plans were revised to control an estimated maximum flow not of 7,000 but of 56,000 sec.-ft. This incident indicates the state of our knowledge of water in many sections of the country according to a report recently submitted by the Water Resources Committee to the National Resources Committee.

Our investment in water

The report, entitled *Deficiencies in Basic Hydrologic Data*, indicates the extent of the national investment in water use and control structures and the degree to which economical and safe design of such structures is dependent upon accurate knowledge of rainfall, snowfall, groundwater levels, stream flow, evaporation, and water quality, and points out the inadequacy of our present knowledge of these factors. A program is recommended for the establishment of a network of observation and recording stations throughout the country. It is estimated that such a network could be established at once at a total cost of $3,676,500, with an annual cost thereafter for operation and maintenance of $1,824,000. The report recommends that the federal government bear the entire cost of establishing first order stations in such a network and share with the local government the cost of subordinate stations.

The magnitude of the national investment in structures intended for protection against water or for making use of water is indicated by a few figures. During the past 15 years, 18,000,000 acres of dry land have been brought under irrigation, 84,000,000 acres of wet land have been drained and $2,000,000,000 has been invested in city sewers and waterworks. At least $374,000,000 was spent for flood protection, irrigation, and navigation in the year 1935 alone. More than $1,000,000,000 has been spent by nonfederal agencies for irrigation projects, waterways and earthworks between 1920 and 1935, and about $1,350,000,000 was spent for bridges during this same period. There can be little doubt, says the report, that the tendency is for expenditures of this nature to increase.

Even greater than the direct investment in our water resources are the indirect investments attendant upon them; urban real estate exposed to floods; cities relying on a plentiful supply of unpolluted water; improved farm lands whose value may be lost by repeated flooding or undercutting; industries which cannot safely plot their future without some means of knowing what water conditions are to be.

The most spectacular danger arising from insufficient information about water behavior is that of hydrologic under-design of water control structures. No less than 60 important dams have failed during the past 50 years as a result of overtopping by floods. A large proportion of these failures would not have occurred if there had been accurate long-term records of precipitation and stream flow, in the opinion of the committee. Another source of danger is in irrigation projects where it is stated that about $6,000,000 has been lost by the federal government alone on ventures designed on the basis of data which later proved unreliable. Many millions more have been lost by farmers who depended on a supply of water that was not forthcoming.

Less obvious than the cost of structures which failed is the cost of overdesign in structures which stand. The large factors of safety made necessary in conservative design by lack of adequate hydrologic information are responsible for unnecessary expenditures to meet conditions that fuller information might have shown would never occur. Thus, while the committee estimates that during the past thirty years about $20,000,000 damage has been done to city storm sewers by water flows they were not designed to meet, it also estimates that at least $30,000,000 has been spent in the past ten years providing capacity which will never be used.

Precipitation

Accurate and comprehensive information on precipitation is fundamental to intelligent planning of water use. There are now about 6,800 stations in the United States at which precipitation is measured. Most of these are maintained by the Weather Bureau. About 300 of the stations are equipped with recording rain gages. The stations not maintained by the Weather Bureau are scattered about the country in a widely spaced and uncoordinated network. The average annual cost of

maintaining the Weather Bureau stations now in operation is about $1,800,000. Allowing half this sum for precipitation observations, and taking into account the expenditures by other agencies, it may be estimated that the federal government spends about $1,000,000 annually for the collection and publication of precipitation data.

The distribution of the expensive first order meteorological stations is adequate throughout most of the country from the standpoint of water conservation activity. There is, however, a deficiency of precise hydrologic data for high altitudes. Several first order stations are needed in the Appalachians, the Rockies and the Pacific Coast Range. They should be located at high elevations, at the top of the great drainage basins. There is urgent need also for continuous records which will show the duration and intensity of precipitation for periods of less than 24 hours. In the opinion of the committee, there should be at least one recording gage for each 5,000 sq.mi. in the United States.

There are still many sections of the United States which do not have enough standard non-recording gages. In Texas, for example, there are areas as large as 8,000 sq.mi. in which not a single gage is operated. Adequate coverage of the deficient areas probably would require at least 1,200 more gages. Provision for annual inspection of all gages by the Weather Bureau is eminently desirable, as is also provision for the publication of many now unpublished records.

The committee recommends the following for the improvement of collection of precipitation data: (1) Establishment of six new first order meteorological stations in high altitudes by the federal government; each of these would cost $10,000 to install and $10,000 annually to maintain. (2) Establishment of 400 new recording rain gages. Installation would cost $110 each, and maintenance $60 per year. (3) Establishment of 1,200 non-recording participation stations. Installation would cost $25 per station and annual maintenance of $10 per station. (4) Compilation, checking, and publishing of records collected at the above stations—this would cost $72,000 annually. (5) Every station in the country should be inspected annually by the Weather Bureau. This would require an annual cost of $55,000. About $25,000 extra would be required the first year to replace equipment found to be unserviceable. (6) Publication of all existing reliable unpublished precipitation data; this would require one year's work costing $55,000. (7) Publication of a detailed statement of the history of each station for which data are published by the federal government; this would cost $55,000.

The entire program of the committee for improving precipitation data would cost $396,000, in the first year, with an annual cost of $223,000 thereafter.

Groundwater level

There is no systematic program at present for the observation of fluctuations in groundwater level. In 1935 about 6,700 wells of all types were being observed periodically. Almost half of these were in Illinois, Florida, Michigan, and Nebraska. The remainder were scattered widely in small groups, the bulk of the observations being restricted to areas where intensive groundwater studies were being carried on. When the studies are completed, the well observations will probably be discontinued. During 1935, about $150,000 was spent by federal and non-federal agencies on such work.

The committee recommends the following minimum program: (1) 4,000 base observation wells should be established in carefully selected locations to be operated permanently by the federal government. Each well would cost about $75 for installation and $25 for annual operation. (2) 6,000 secondary observation wells should be established on a cooperative basis with states and municipalities and should be located in areas of special interest. They would be discontinued in many areas after several years' records had been obtained and the water level fluctuation correlated with those of the base stations. (3) About $100,000 per year should be spent on geologic and hydrologic investigations to determine the most satisfactory location of wells.

The cost of constructing new wells should be spread over two years. This would give a cost, for the program, for the first two years, to the federal government of $406,250 and $493,750, respectively; non-federal agencies would contribute during the first two years $131,250 and $168,750. Continuing annual costs thereafter would be $312,500 to the federal government and $112,500 to non-federal agencies.

Stream flow

Records of stream flow from which discharge quantities can be obtained are kept at about 3,100 stations in the United States. Most of these stations are maintained cooperatively by the federal government and local agencies. During the year 1935 about $1,540,000 was expended by or under the direction of the U. S. Geological Survey on streamflow study programs. About $1,000,000 of this sum was provided by the federal government.

Stream gaging work in the United States is deficient in two major respects: there are not enough stations in many sections of the country, and there are not enough records that have been continuous over a long period of years. As a general rule, a record of at least 40 or 50 consecutive years is necessary for the preparation of reliable estimates of maximum and minium flows.

The committee considers that the essential continuity of observation can best be obtained by establishment of a net of primary stations operated at federal expense.

During 1933 the PWA allotted funds for the rehabilitation of about half the gaging stations in operation. A recent allotment has also been made to repair stations damaged by the 1936 flood. However, half the stations are still in need of overhauling.

The committee's recommendations are: (1) 1,100 new stream gaging stations should be established. (2) The federal government should give full financial support to at least 500 base stations in addition to the small number now operated. All of these stations should have recording gages. A new recording station of this class would cost $2,000 per installation and $500 per year for operation. (3) The remaining 600 stations needed should be established on a basis of 50-50 cooperation between federal and local agencies. If half of these stations were of the recording type, the average cost of installation would be $1,500 and of maintenance $400. (4) About $1,000,000 should be spent on rehabilitating old stations which are in need of repairs.

The first year cost of this program to the federal government would be $1,450,000, and to non-federal agencies $450,000; the annual maintenance cost would be, to the federal government, $370,000, and to non-federal agencies $120,000.

Other elements of program

Believing that in many parts of the country snow surveys furnish the only reliable means of forecasting streamflow, the committee recommends that to the 500 snow survey courses now operated by the federal government on a cooperative basis with the states should be added 500 more courses financed in the same manner. Establishment of these courses plus a small appropriation for research on the technique of snow measurement would bring the cost for the first year of a snow survey program to the federal government to $169,000 and to non-federal agencies $39,000. Maintenance costs thereafter will be $58,000 to the federal government and $12,000 to other agencies.

At present, information on the variations of evaporation in different parts of the United States is very scanty. Only 156 evaporation study stations are now maintained by the federal government. The committee recommends that 280 new stations should be established. The cost of publication and research would bring the total cost to $35,000 the first year and $16,000 thereafter.

No nationwide program for the collection of data on the quality of water is now in operation. Present studies of this subject are all directed at the solution of specific and local problems. The committee believes that a broader scale program for the study of water quality should be begun. For this purpose it recommends that 200 base stations, at which mineral content, hydrogen-ion concentration, dissolved oxygen, turbidity, and suspended load would be measured, should be established in a comprehensive network over the United States. These should be located at existing stream gaging stations and should be maintained continuously for at least ten years. Half of these stations should make regular measurements of water pollution. It is also recommended that 400 secondary stations should be operated in different locations for one year periods, returning to the same location at intervals of five or ten years. The total annual cost of this program to the federal government would be $450,000 and to non-federal agencies $150,000.

In allocating the cost of the above program of water observations, the committee has followed the general principal that the federal government should bear the cost of a basic network of observation and should share equally with non-federal agencies the cost of a program of secondary observations supplementing the basic network. In certain fields of data having very broad uses, notably precipitation and evaporation measurement, the committee feels that the federal government should bear the entire cost of the program.

Resurfacing 29-Year Old Streets At Lawton, Oklahoma

By W. B. Kendrick
City Engineer, Lawton, Okla.

AFTER 29 YEARS of service, 72 city blocks in Lawton, Okla., that were paved with native rock asphalt are being resurfaced using crushed limestone and emulsified asphalt. The work has been financed by various means. Normal methods of financing street repairs by special assessment being impracticable, the city set out to determine the cost of doing the work with regular city funds, resurfacing 5,000 sq. yd. at street intersections. This work was done at a cost of 48c per sq. yd. On this basis the city undertook to do 22,000 sq. yd. Thereafter local civic organizations raised funds for 18,000 sq. yd. additional work, giving the work to unemployed citizens who were ineligible for relief. Thus a total of 45,000 sq. yd. of street surface was repaired. On Aug. 1 of this year the WPA took over the remaining 95,000 sq. yd. To finance, the actual cost to the property owners will be 20c a sq. yd.

Lawton, a city of 12,000 population, in 1907 laid 76 blocks of asphalt streets on a crushed limestone base. With the exception of four blocks resurfaced in 1931 and occasional patching of the worst holes as they developed, no maintenance work has been done on these streets. Consequently, the entire area has weathered to the extent that surface cracks have allowed moisture to soften the base, and during the past two winters freezing weather made some next to impassable. The four blocks noted were resurfaced with emulsified asphalt using a penetration method costing $1.15 per sq. yd.

The resurfacing test made at street intersections was carried out with equipment on hand, materials being purchased with funds provided by the regular municipal street department budget.

AFTER 29 YEARS OF SERVICE pavements of rock asphalt on a crushed limestone base have weathered and cracked allowing moisture to penetrate and soften the base.

SPREADING AND ROLLING the first course of 1½-in. coat of asphalt coated limestone. After rolling, a top coat of ¼-in. screenings without an asphalt seal coat was placed.

Repair operation

For the repair operations, 1-in. crushed limestone was mixed with 7 per cent by weight of emulsified asphalt in a 21-E paving mixer. The old asphalt streets were swept clean and all loose material removed. All holes were mopped with asphalt, brought to grade with 1-in. stone and rolled. The entire old surface was then mopped with asphalt at the rate of 0.2 gal. per sq. yd. and covered with the asphalt coated rock to an average depth of 1½ in. This was rolled

with a 5 ton, three-wheel roller. Subsequently, ¼ in. chat screenings were mixed with 12 per cent of asphalt and spread over the coarse aggregate ¼ in. to ½ in. thick. This top coat was rolled and then dusted with the fine dust that had been screened from the ¼ in. chat. The usual seal coat of liquid asphalt was not applied to the finish surface, but dependance was placed on the large per cent of asphalt added to the surface chat course to seal out the moisture. Also it was felt that the continued hot weather through the summer months would keep any seal coat in a liquid state, causing traffic to pick up the asphalt and tending to destroy the seal. Should winter conditions indicate the surface is not sufficiently sealed a light liquid seal coat will be applied.

A central mixing plant was used, located an average distance of 1 mi. from the street under repair. The source of crushed stone was 13 mi. from the plant. Asphalt was piped direct from the tank car to the mixer where it was measured in buckets and poured into the mixer. Two 6-hr. shifts of fifty local unemployed residents, not eligible for relief, were used, laying an average of 2,000 sq. yd. per day.

Some 12,000 sq. yd. of this surfacing has been placed on a gravel base, where the curb and gutter was already in place. The only difference in the procedure of construction was that the tack coat was not placed on the gravel base and the coarse aggregate was placed 2 in. thick. Though there have been two heavy rains on an area that was placed four months ago no trouble has developed from moisture going through and softening the base.

Equipment owned by the city and used on the job consisted of one 21-E paver, one 5-ton roller, four 1½-ton trucks and small tools such as picks, shovels, rakes, wheel-barrows and buckets.

Hodges Dam Strengthened

Cracks in thin concrete buttresses and need for rigidity to resist earthquakes led to reinforcement of the 18-year old multiple arch dam of the San Diego water system by building rigid vertical frames on alternate bays.

By Fred D. Pyle
Hydraulic Engineer, City of San Diego, Calif.

HOW TO STRENGTHEN and increase the rigidity of Hodges Dam, a very light multiple-arch structure that lacked adequate transverse bracing and whose buttresses were cracked, has been a problem confronting the city of San Diego for years. An important unit in the city's water supply system was involved, not alone with respect to the loss of water storage but in the matter of risk to life and property below. In addition to the engineering problems, joint ownership of the structure gave rise to the question of how the repair cost should be allocated. Under these conditions decision about repairs was deferred from time to time for nearly a decade.

Failure of the St. Francis Dam in 1928 emphasized the risk inherent in dams of doubtful stability. In 1929 a board of consultants (L. C. Hill, C. R. Olberg, C. F. Tolman and A. J. Wiley) suggested a stress analysis of Hodges Dam. Subsequently the Long Beach earthquake, followed by the passage of state laws requiring new standards of safety in making structures resistant to seismic shocks, focused attention sharply on the frailty of Hodges Dam and the urgent need of adequate horizontal bracing or stiffness to withstand earthquakes. Comprehensive studies were made, various alternatives in design were considered, and finally a contract was awarded early this year for carrying out a program for strengthening developed in San Diego with the cooperation of the state engineer's office and approved by the state engineer Nov. 17, 1934. A description of the dam written shortly after its completion was published in *Engineering News-Record*, April 10, 1919, p. 720; in the following are outlined essential features of the strengthening now under way which are unusual from engineering and construction viewpoints.

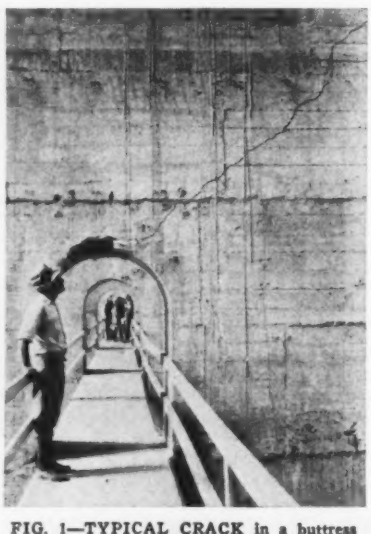


FIG. 1—TYPICAL CRACK in a buttress as seen from walkway through the dam. The upstream is to the right. Note spalling over opening.

Hodges Dam history

The Hodges dam, designed by the late John S. Eastwood, was constructed in 1917-18 by the San Dieguito Mutual Water Co. It is located on the San Dieguito River about 30 miles from San Diego and some 12 miles above the point where the river empties into the Pacific Ocean. The drainage area above the dam is about 303 sq.mi. The top of the dam, at El. 330, is 130 ft. above streambed and the maximum height above lowest foundation is 136 ft. The spillway is 115 ft. above streambed and is 343 ft. long. The foundation is solid rock close to streambed level. The crest length is 616 ft. and the reservoir capacity at spillway level is 37,700 acre-ft. The structure consists of a number of concrete buttresses slightly more than 4 ft. thick at streambed and only 18 in. thick at the top. These buttresses, spaced 24 ft. on centers, support a series of inclined arches or barrels. The arches are reinforced but, like the buttresses, are quite thin, decreasing from a maximum thickness of 2½ ft. at the base (in the highest part of the dam) to 1 ft. at the top.

The buttresses have no reinforcing except where they are bonded to the arches and around doorway openings over a walkway. The arches, adequately reinforced to transmit water load to the buttresses, were finished off on the upstream face by a coating of shotcrete. The dam was built long before the day of vibrators, and to permit delivery of concrete by chutes, as was the custom then, a wet mix was used. The proportions, both in the arch and in the buttresses, were approximately 1:2:4. Construction was well done and considering the methods then in vogue the concrete is remarkably good.

In February, 1918, before construction was completed, a flood overtopped the crest of an unfinished arch. This one arch had been left some 25 ft.

below the level to which other arches had been completed and for several days the flood poured through this opening, reaching a maximum overpour depth of 20 ft. Despite the impact and vibration doubtless associated with this concentrated flow no damage was done.

When Hodges dam was built California had no state supervision of dams such as was set up after the St. Francis failure. Therefore, after receiving the approval of the designer and the then state engineer the dam was accepted as a safe structure. There was some difference of opinion as to the capacity of the spillway. This was claimed to be 70,000 sec.-ft. as originally built, but inadequacy of approach channel later led to the conclusion that the actual capacity was much less. In 1930 the spillway was widened by excavating into the hillside, and since then its rating has been 68,000 sec.-ft. With the help of ponding in the reservoir, an inflow of about 100,000 sec.-ft. can be controlled. The maximum *recorded* discharge over the spillway occurred on Feb. 2, 1927, and amounted to 45,000 sec.-ft., the overflow depth being 11 ft. 8 in., but the peak flood flow of the river in 1916 (just before the dam was built) has been estimated at 72,100 sec.-ft.

The city of San Diego acquired the water system of which Hodges Dam is a part from the water company in 1925 by lease with option to purchase. The total price to be paid for the properties was $3,750,000, of which the city still owes about $3,000,000. Thus there is a joint interest in any reconstruction that goes beyond repairs incidental to ordinary maintenance.

Cracks cause alarm

Not long after completion of the dam a crack began to appear in each of the higher buttresses, extending in a generally downward direction at right angles to the inclined upper edge of the buttresses. From a starting point about one-third the distance up the inclined edge they rather uniformly head for the top of the openings by which the walkway passes through the abutments. The cracks continue on diagonally downward from the lower downstream corner of the openings.

Bronze spuds were grouted into the concrete on either side of these cracks and measurements of the crack width have been made for several years. Evidence is conclusive that they have steadily increased in width; maximum width is attained during the winter months and minimum width during the late summer. Each season the dimensions have increased slightly over those recorded the year before.

Although different cracks differ in width, openings of $\frac{3}{8}$ to $\frac{1}{4}$ in. are not uncommon and daily variations between 6 a.m. and 4 p.m. are measurable on a micrometer reading to 0.0001 in. Higher temperatures tend to close the cracks. Generally speaking there is only one large crack in each buttress. The uniformity with which all these cracks strike the buttress doorway openings has suggested that the openings have some relation to the cause of the cracks. However, the end buttress on the left bank, through which there is no opening, has a crack in the same location in which it occurs in the other buttresses. Fig. 2 shows the walkway through the buttresses and a typical crack. Over the opening the concrete has spalled off to disclose a reinforcing bar. Bronze spuds used in measuring crack movement can be seen to the right of the opening.

At ordinary water levels there is no tensile stress due to water load at the

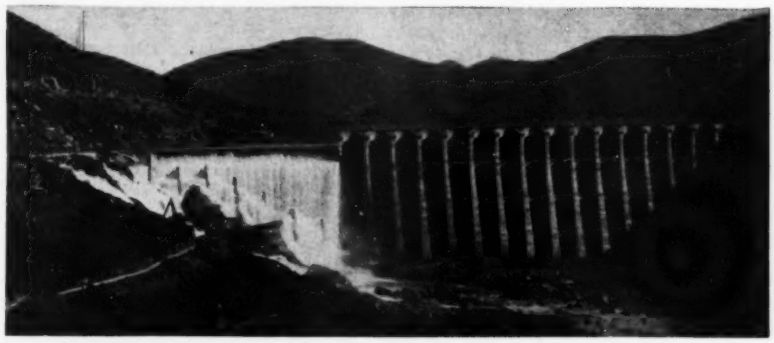


FIG. 2—HODGES DAM from downstream. Apparent thickness of buttresses is greater than the actual thickness by reason of a flange or face on the downstream edge.

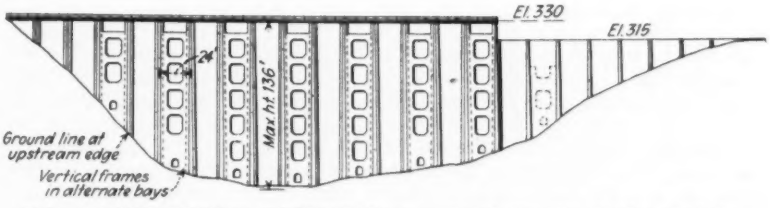
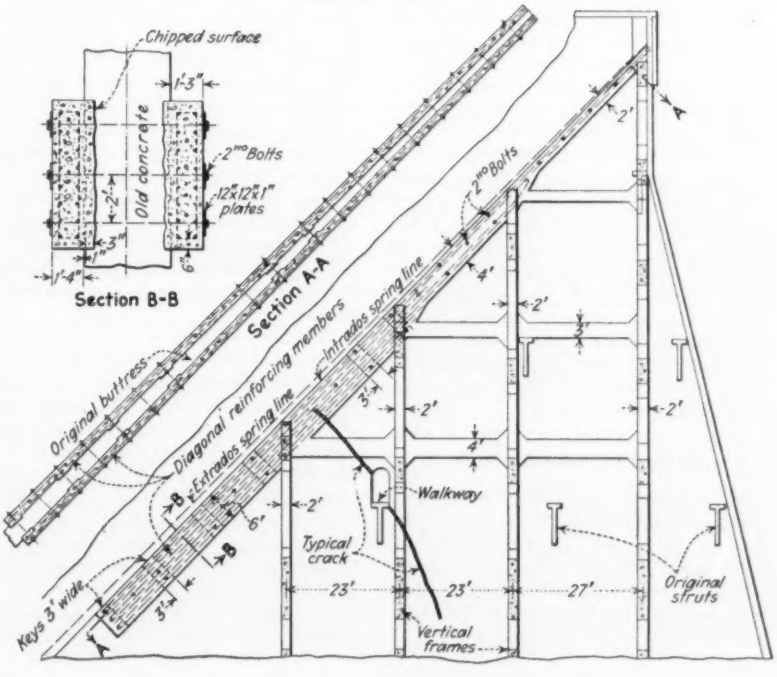


FIG. 3—LONGITUDINAL ELEVATION from downstream side showing vertical frames in alternate bays.

FIG. 4—THE STIFFENING SYSTEM consists of vertical frames and diagonal reinforcing members.



upstream face of the buttress and the change in width of the cracks is independent of the water level in the reservoir. It has therefore been concluded that the cracking is due entirely to volume change of the concrete in hardening and later under temperature change.

Repairs decided on

The desirability of strengthening Hodges Dam buttresses had long been recognized; some studies were made soon after the St. Francis Dam failure. However, it was not until the Long Beach earthquake (1933) and the resultant focusing of interest on structural stability that comprehensive studies were made with a view to increasing the lateral stability and rigidity of Hodges Dam against seismic shocks. The height and slenderness of the unreinforced buttresses, their light bracing and the long crack in each of them, coupled with the fact that the dam is located in a region of know seismic activity and that there is great risk to life and property in the valley below the dam, made it imperative to carry out some strengthening program. The need for strengthening was more apparent to engineers than to the voters—the proposed expenditure would not extend nor improve the water supply in any way but was merely to increase the safety of a structure that was supposed to be adequate as originally built and had stood securely for more than fifteen years.

The valley between the dam and the sea contains a population of several hundred, a fertile farm area of about 5,500 acres, improvements valued to exceed $1,000,000, nearly a mile of the main highway from San Diego to Los Angeles, and a similar length of Santa Fe railway main line. Failure of Hodges Dam would threaten destruction of all these, would reduce San Diego's available water supply seriously and would cut off the water supply of two irrigation districts outside the San Dieguieto Valley representing a total population of about 3,300 and 4,500 acres of irrigated orchards.

Under the pressure of these conditions, finances were provided by city appropriations plus a 45 per cent PWA grant. By way of contributing the share of the original owners, the San Diego Water Supply Co., successors in interest to the original owners of the dam, made available the value of the cement used in the strengthening program. The total estimated cost of repairs is about $150,000.

Structural reinforcement

No precedent was found for strengthening single-slab buttresses in a structure of this type. Numerous designs were worked up and investigated by the city's engineering staff before a solution mutually satisfactory to the state engineer and to the city was arrived at. Simply stated, bracing in a direction transverse to the planes of the buttresses was a major requirement. However, it was not desirable to use through struts because the 600-ft. total length of such members would accumulate so much stress that undesirable deflections would result if struts and buttresses were bonded. Consideration was given to the late F. A. Noetzli's twin buttress plan and to a meritorious structural framing suggestion made by H. D. Dewell, San Francisco.

The design finally selected is an approach to the twin buttress type. Under this plan rigid vertical frames or bents were built up in alternate bays and large diagonal reinforcing members containing ample steel bars were cast on each side of the upstream, diagonal edge of each buttress from foundation line to the top of the dam. The diagonals constitute a rigid upper-end anchorage for the vertical frames. This plan gives adequate rigidity without carrying movement longitudinally through the dam.

The diagonal reinforcing members, which would prevent even a heavy seismic shock from severing the buttresses along the existing cracks, were anchored into the buttresses by keyways in the old concrete and were clamped together by 2½-in. steel bolts. Because these diagonals were clamped to the buttresses in that zone where the arch reinforcing is embedded, they may be considered structurally as taking the stress which is brought into the buttresses through the arches. The diagonals decrease in width by two successive steps from 6 ft. at the base of the arches to 2 ft. at the crest of the dam.

Particular attention was given to avoiding any danger that cracks in the buttresses would extend into or cause corresponding cracks in the newly placed concrete members. Although the face of the buttresses was chipped and keyways were used to make good bond between the new concrete of the diagonal member and the old concrete of the original buttress, this bonding was omitted for 5 ft. on either side of each diagonal crack. In these areas near cracks the buttress was coated with an asphaltic paint before the concrete of the diagonal was poured. Similarly, the bolts put through the diagonals and buttresses were kept 7½ ft. away from the cracks.

All new concrete was provided with heavy reinforcing; steel bars up to 1¼ in. in diameter were used and were lapped 40 diameters at joints. Particular care was taken to get an exceptionally good concrete job. Specifications called for a concrete mix very similar in proportions to the original 1:2:4; but in the present work a slump of about 2 in. was used and a strength of 3,000 lb. per sq.in. in 90 days was specified. Low-heat cement was used, to minimize shrinkage.

As reconstructed, analysis of the dam shows it to be able to resist a horizontal force of 0.1 g. either at right angles or parallel to the buttresses. Under the first condition the structure probably is safer when the reservoir is full or partly full than when it is empty. Under the second condition the structure becomes a series of well-braced twin buttresses connected by the reinforced arches that add to the rigidity of each pair and connect the pairs.

The assumption was first made that frame and buttresses act together as a unit, somewhat in the manner of an *H*-beam standing on end. The horizontal forces assumed to be acting on the tallest frame were as follows:

Elevation	Force (lb.)
320	21,600
300	39,900
280	33,000
260	48,000
240	67,700
220	91,700

This analysis was made on the basis of a vertical cantilever with the frame acting as the web. The result was no tension in the vertical part of the frame because the weight of the buttress counteracted such a tendency from horizontal forces.

It was then doubted that the frames could be made integral with the buttresses and they were re-analyzed as cantilevers fixed at the base, obtaining no aid from the buttresses to counteract the vertical tension but prevented by the buttresses from the occurrence of bending in the vertical members of the frame. This resulted in heavy shears in the horizontal struts, and the frames were designed accordingly.

For comparison, the stresses were investigated by the portal method, frames independent of buttresses. Where bending moments or shears were larger than by the other methods, provision was made for the larger stresses.

An attempt was made to solve the frame by using the Hardy Cross method. However, because of the relative stiffness of the horizontal struts to the vertical portion of the frame the convergence of the approximations was too slow.

Because of the 45-deg. slope of the buttress and its relative shortness, the second principal stress is tension parallel to the spring line of the arch. To prevent sudden separation of the buttress into two parts when water level reaches the top of the dam, enough steel was put into the diagonals to carry this tension. The tension is transferred to the diagonals by the keyways in the buttress and by the steel anchorages at the top of the buttress on the downstream edge.

Construction methods

Work began on the strengthening contract March 27, 1936. Because no blasting was allowed within the bays, excavation for the foundation of the ver-

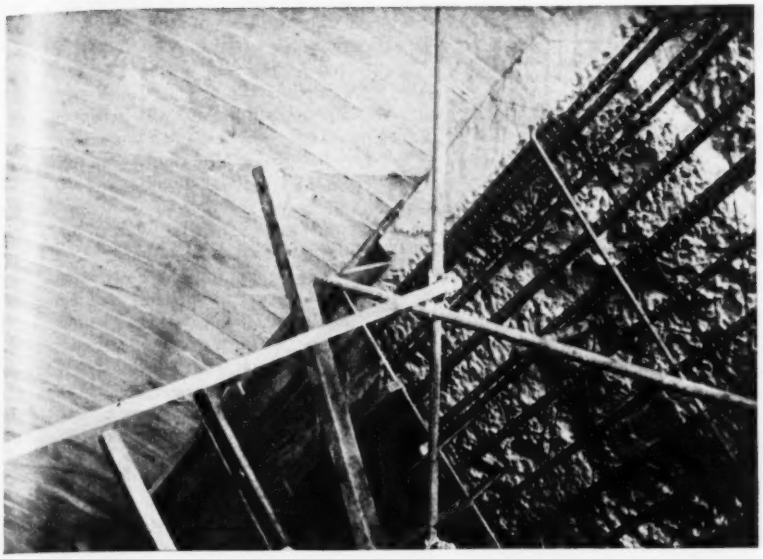


FIG. 5—CHIPPED SURFACES and keyways are used to bond old and new concrete. Steel bars for diagonal reinforcing member are shown. Note bolt through buttress in right center. Upper left is the downstream face of an arch.

tical frames was carried on by hand tools. The vertical bands or areas in which these members contact the buttresses were marked off and roughened by chipping with pneumatic tools. Likewise the areas in which diagonal members were to be bonded to the upper edge of the buttresses were roughened, except near the cracks.

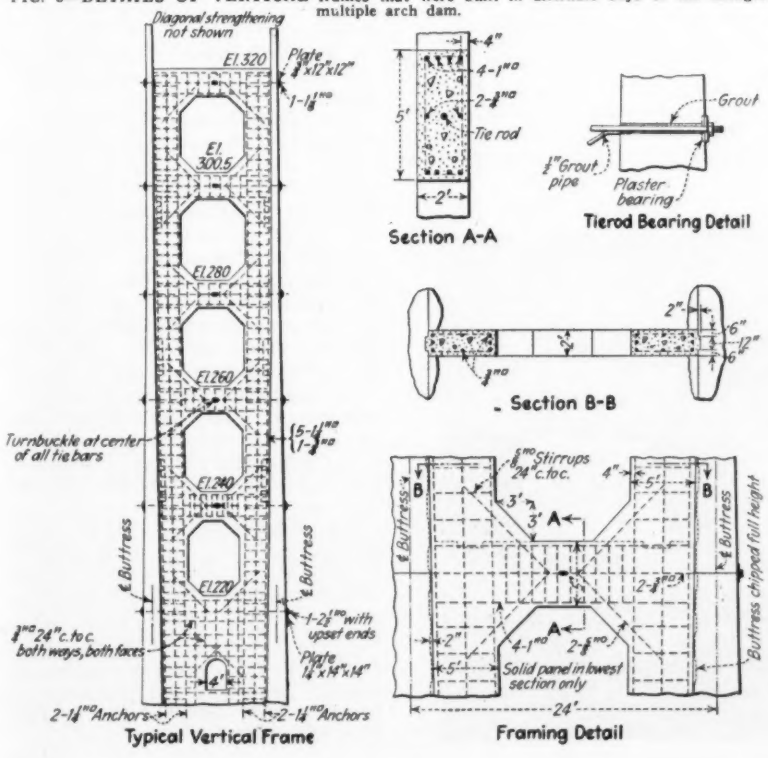
In the vertical frames the reinforcing steel, assembled in place with horizontal ties 24 in. on centers, served as convenient scaffolding for the workmen who did the concrete chipping. In the diagonal members it was convenient to drill the holes through the buttresses for the ties first, and after the ties had been placed to use them as supports for the reinforcing steel of the diagonals. After reinforcing was in place forms were built up around the various members and concrete was delivered through a 6-in. pipe from a concrete pump on one end of the dam. The delivery pipe terminated in a hopper which was moved from bay to bay as work progressed. From the hopper hand buggies wheeled the concrete to the forms on scaffolding built up in the bays as required.

The ties through the buttresses to insure unity between old and new concrete were tightened effectively. The size of steel plates used under the nuts on each end of a tie varied somewhat in size and thickness; 14 in. square and 1¼ in. thick was a maximum. After ties, plates and nuts were in place, grout was forced in behind the plates through a small pipe inserted for that purpose when the tie was placed. When the concrete had set, a tension of about 5,000 lb. per sq.in. was put into each tie by means of ratchet wrenches.

At the upper ends of the diagonals special methods were used to insure tension in the longitudinal reinforcing. An anchor block of concrete was cast early in the work on the downstream edge of the buttress at the top. Around reinforcing within this block were passed two loops of the 1¼-in. steel bars of each diagonal member, and the ends of the looped bars were connected to the corresponding reinforcing in the diagonal by means of turnbuckles, to prestress the steel before concrete was poured around it. Four 1¼-in. bars in each diagonal near the upper end prestressed in this way are believed to strengthen the upper end of the buttresses materially and may even close a construction-joint at the buttress top.

The original dam was built by Bent Bros., contractors, of Los Angeles. The present work is under contract to M. H. Golden, San Diego. The design was developed and construction is under the supervision of the author as hydraulic engineer in charge of development and conservation for the San Diego Water Department. Paul Beermann is assistant engineer and L. H. Hill is resident engineer.

FIG. 6—DETAILS OF VERTICAL frames that were built in alternate bays of the Hodges multiple arch dam.



Diversion of Colorado River Effected at Parker Dam

Diversion of the Colorado River through two tunnels at the site of Parker Dam has been successfully effected. Parker Dam, 155 miles downstream from Boulder Dam, is being constructed to re-regulate the river, generate hydroelectric power, and to divert water into the aqueduct of the Metropolitan Water District of Southern California.

The river is diverted through two tunnels 29 ft. in diameter and 1,730 ft. long, drilled through the mountain on the Arizona side of the river. The river will flow through these tunnels for about two years before it is returned to its normal channel to build the reservoir and flow over the completed crest of the dam. At the end of their service as diversion tunnels, these bypasses will be sealed.

Concrete X-Ray Room Built Without Lead Lining

Installation of thick concrete walls at Rock Island Arsenal laboratory gives same degree of protection as lead lining and at reduced cost

CONCRETE instead of lead to protect laboratory operators using one of the largest industrial X-ray units in this country, is proving satisfactory at the U. S. Arsenal at Rock Island, Ill. The X-ray room, with the walls, foundation and ceiling made of concrete, was designed for the use of a 400,000-volt and 10-milliampere X-ray unit. Plans for its construction called for a floor space 20 ft. square and a ceiling height of equal 20 ft. The estimated cost of labor and materials to provide a layer of lead as part of the walls and ceiling was $7,000. Had lead been used as the X-ray absorptive material, concrete walls and ceiling would have been used for supporting the lead. By increasing the thickness of the concrete sufficiently so that a layer of lead was not needed, a saving of $6,000 was made.

The concrete mix used was one sack of cement with 2.3 cu. ft. of sand, 3.5 cu. ft. of aggregate, and sufficient water to make a workable mix. The foundation was a 36-in. layer of concrete placed upon rock. The 24-in. walls were deposited in heights of 8 ft. because of the weight involved. To eliminate the possibility of horizontal cracks between the layers of the walls, a longitudinal set-off was provided along the centerline of the walls at each joint. A similar procedure was followed at the corners to prevent vertical cracks. A 10-in. thickness of concrete forms the ceiling. Because the building housing the radiograph room is a one-story structure at the point where the room was built no additional thickness was considered necessary for the ceiling.

To allow access to a craneway on one side of the room a 12 x 14-ft. doorway was provided with a metal door covered with a $\frac{1}{8}$-in. layer of lead. Another door, 3 x 7 ft., leading into the laboratory office and control room was lined with a $\frac{1}{8}$-in. layer of lead. A window, composed of six layers of lead glass and protected by a movable lead shield, was also constructed near the small door so that a technician might observe the operation of the X-ray unit from the exterior of the room.

When construction of the compartment was completed a test was made to determine the lead equivalent of concrete under certain constant conditions. The accompanying table shows the results for four thicknesses of concrete.

X-RAY ABSORPTION CAPACITY CONCRETE VS. LEAD

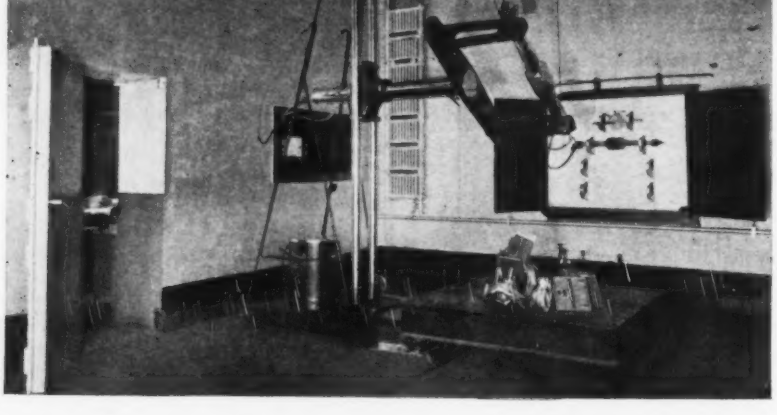
Concrete, In.	Equivalent Lead, In.
4	0.050
10	0.137
14	0.225
19½	0.550

A survey for a period of 60 days during regular routine testing showed the walls satisfactory. In this survey dental film was placed at various points on the outside of the walls, and no darkening of this film could be detected at the end of the 60-day period. As further proof that the X-rays were not penetrating the walls a film was exposed on the outside of one of the walls for 10 min. while the X-ray tube was operated at 300,000 volts and 10 milliamperes at a point 25 ft. from the interior surface of the wall. No effect upon the film was noted.

Two explanations are given for the X-ray absorption property of concrete: First, that the rays are widely scattered before any great penetration takes place. Second, that the scattered radiation is of longer wave length than the initial rays and thus more easily absorbed by the remaining thickness of the material.

Paul C. Cunnick, working under the supervision of Major F. C. Shaffer, is in charge of the X-ray laboratory.

THICK CONCRETE WALLS enclose x-ray room at Rock Island Arsenal



Artesian Water In the Florida Peninsula

ARTESIAN WATER, one of the most valuable natural resources of the Florida peninsula, is the source of most of the large and many of the small water supplies in the area, according to a report just published as Water-Supply Paper 773-C by the United States Geological Survey, Department of the Interior, and obtainable from the Superintendent of Documents, Washington, for 20 cents. The largest amounts of water are used for the irrigation of crops in coastal areas, in irrigation districts, as in Seminole, Manatee, and Sarasota Counties, and also by Jacksonville and some of the other cities.

The principal artesian formations are the Ocala limestone, of Eocene age, which underlies the entire peninsula, and the Tampa limestone and Hawthorn formation, of Miocene age. The Ocala and Tampa limestones contain cavities at depths of as much as several hundred feet below sea level. The formations are folded into a large anticline that extends through the peninsula and plunges toward the south. This structure is favorable for artesian conditions, which are present throughout the peninsula except locally in recharge areas. In part of the area, however, the artesian conditions and the movement of the water are independent of the structure.

The porous limestones are the source of some of the largest springs in the United States and yield copious amounts of water to wells. The measured flow of Silver Springs, one of the largest, has been more than 800 m.g.d. Wells supplied by the artesian formations are present throughout the peninsula and range in depth from less than 100 ft. to more than 1,000 ft.

CURRENT HIGHWAY PROBLEMS—VI

Township Roads

Centralization indicates a change for the better but problems in financing are not yet solved

By Murray D. Van Wagoner

State Highway Commissioner of Michigan, Lansing, Mich.

IT IS DIFFICULT to discuss township roads in general terms. In certain sections of the country township authority over roads is negligible and in other sections it is complete and fully exercised. Obviously the subject presents different aspects under the two conditions. The best compromise exists where road administration has been quite definitely divided between townships, counties and the state, as in Michigan. Michigan also has grappled earnestly with its township road difficulties so that general lessons can perhaps best be drawn from its experience. The article that follows is then a specific case history not yet fully worked out but indicating clearly certain fundamental conclusions. The two that seem unquestionably certain are (1) that vastly improved township roads have followed transfer to larger administrative authority and (2) that such transfer calls for definite and positive revision of the highway financing plan. The last is a highly important lesson for the public to learn. —EDITOR.

A REVOLUTIONARY shift in the administrative and financial responsibility for town roads has just been completed in Michigan which breaks, for the time being at least, all continuity with the past. The conditions and problems of local road administration in Michigan are those of a time of change. About the only things that are clear and definite are the difficulties; the solutions are taking shape, but they are still blurred by uncertainties as to the exact facts. However, since the problems of transition are not limited to any one state, a presentation of the situation in Michigan will be valuable as a picture more or less typical of a much wider section of the country.

Segregation begun

The building and maintenance of Michigan roads was originally a matter of purely local concern. Township road commissioners supervised and controlled all highway activities under the direction of township officials. Tax levies on all the property in the township paid the costs. This system of local control and support of the highways was responsible for practically all the road development of our territorial period and continued through the first half-century of statehood. In 1893, however, a law was passed providing for county road systems under the supervision of county road commissioners.

The growth of the county system was slow, but in certain communities considerable progress was made and an incentive seemed desirable to encourage higher standards for the work which was being done. So in 1905, although only 18 of our 83 counties had organized highway commissions, a state-reward road law was enacted which enabled the state to contribute from $250 to $1000 per mile for county roads built to approved specifications. The State Highway Department was created to administer the law.

The State Reward Road Act, which was the first step in transferring the support of highways from local taxpayers, was repealed in 1925, but the process of shifting responsibility continued. By a series of legislative measures, the state highway system was established and extended. In 1915 the State Reward Act was expanded, in 1917 the state complied with the Federal Aid Highway Act, and in 1919 a $50,000,000 state highway bond issue was authorized. At first construction and maintenance of the new state system was carried on by both the state highway department and the county road commissions, but in 1926 the state department took over all the cost of these activities.

An inventory of Michigan trunklines and county and local roads made in 1930 showed a total of 85,409 miles of highway. Of this mileage 9.1 per cent or 7,790 miles was included in the state and federal-aid system, 20.3 per cent or 17,302 miles were country roads, and 70.6 per cent or 60,317 miles were local or township roads.

In the meantime a system for financing these roads had been developed which, under conditions existing in the 1920's, was adequate, or approximately adequate, for the purpose. A tax on gasoline and one-half of a weight tax on motor vehicles made the state system self supporting. The other half of the weight tax was returned to the counties, and this supplemented by county taxes was usually sufficient to meet the needs of county roads.

According to present standards the local roads, supported entirely by real estate taxes, were not satisfactorily maintained, though it must not be forgotten that standards have changed. In the special road assessment districts, while the ambitious programs undertaken by many of them imposed heavy tax burdens on the affected property owners, the enhancement in real estate values and the expectation of further enhancement, rendered these burdens bearable up to the year 1929.

The depression created many obstacles for highway authorities to hurdle, and not the least of these was the shrinkage and disorganization of the revenues on which they were accustomed to depend. The shrinkage was great, but it was a phase of the depression which has tended to correct itself as conditions have improved. However, the derangement that has resulted from attempts to meet serious but temporary emergencies by statutory changes in the highway fiscal system is still with us and will be difficult to remedy.

These statutory changes may be divided roughly into two classes; those which were looked on as general remedies and those which were aimed to cure specific ills. In the former class the most important was a 15-mill tax-limitation act with whose character and operation every one interested in public works is familiar. In the latter class the most important were the McNitt Act of 1931 and the Horton Act of 1932.

Counties take over

The two last named measures dealt, the one directly and the other indirectly, with the depression problems of the local highways. Together they marked a practical severence from the former policy of local support of local roads.

The McNitt Act provided for the transfer during a 5-year period of all local or township roads to the county road commissions and for the relief of the townships from most of their financial responsibility for them. The final operation in the transfer of township roads occurred this year, but in 1937 a very large additional mileage of streets and alleys in recorded plats outside

OIL-AGGREGATE surface on a road that goes through a prosperous farm area of Michigan, an improvement that is regarded as sound expenditure of public funds.

municipalities will be added to the county systems.

To cover the cost of maintaining these roads $4,000,000 appropriated from the state highway department's gas tax revenues is divided among the counties on a township-road mileage basis. The McNitt Act also provides that deficiencies for either maintenance or essential construction may be met by a tax levy, in the one case on the county at large, and in the other on the affected township, but in both cases within the 15-mill limitation.

The Horton Act returned all of the weight tax to the counties, but only one-half of this grant is allotted to general highway purposes. The remaining half is used according to the following priorities: the relief of special road assessment districts, the reduction of taxes for county and then township road and bridge bonds, and various maintenance and debt services in the county and cities, apportionment being made in the last priority on a population basis. A sum of $2,550,000 which was appropriated from the state department's gas tax revenue, is similarly distributed as an off-set for reduction of the weight-tax rate.

Thus the highway system of Michigan which started as a purely local undertaking with the responsibility for both its supervision and its financial support resting exclusively on thoroughly decentralized township units, has been radically changed. New needs and new types of highway transportation have superimposed on the old system of local roads the state and county highway systems. Because their service is wider and more general, their administration is centralized and they are supported by a broader revenue base.

No functional change

But the local road system still persists. The services it renders and the communities it serves are not fundamentally different from those for which it was created more than a century ago. It still connects farm with farm, the farm with the rural trading center, and the rural areas with the county and state trunklines which have largely supplanted the railroads as links to more distant sections and cities. The only factors which are radically different are its administration which has passed into county hands, and its financing which has become more and more a matter of state responsibility.

It is a mistake to think of the local road as merely a feeder for the county and state systems; it was originally a neighborhood road and only became a feeder when the railroads were built. With the coming of the county and state trunklines it still performs a neighborhood function and is only subsidiary to the larger systems to the degree that it was subsidiary to the railroads.

Its service to the neighborhood includes the maintenance of dependable contact with the post office, with the school, with the church and with the village store. Farm equipment passes over it in moving from field to field and from farm to farm. If the district has telephone and electric service, the lines are commonly placed in or adjacent to the local road, and repair and maintenance is dependent upon it. It is the doctor's route to the sick-bed.

Its feeder service consists largely in providing connection with the county and state highway systems and the railroads for the movement of crops and for business and social contacts with more or less distant places.

Sometimes it is used as a link between points outside its own neighborhood, but when this use overshadows its local function it should be transferred to another classification. On the other hand, in many cases the demand for the services of a local road has dwindled to almost nothing, and in such cases there should be no hesitation about its abandonment.

The travel over local roads is not heavy. A survey of traffic on Michigan roads made in 1930 showed that although the township roads comprised over 70 per cent of all road mileage, only about 5 per cent of the total car-miles were produced on them.

The proportion of the total highway expenditure in the state which was devoted to the local roads was in keeping with their use, being 6 per cent or $6,264,400. On the basis of the township mileage later certified under the McNitt Act, this provided a statewide average of just over $100 per mile.

Of course there was a wide variation in the amounts levied in the different townships for road purposes. The more densely populated and richer units often furnished very ample funds to build a first class highway system, and in exceptional cases they got it. But the more typical township splashed along in the mud either because it was unable to produce sufficient revenues or because its road affairs were inefficiently organized and managed.

And faults in organization and administration were certainly frequent enough. Not only were the township units much too small for economical road operation, but sometimes the township was subdivided—in one instance, at least, a single township was divided into no less than 60 road districts. Of course that was an extreme case, but it is clear that no ordinary township commission could afford either the personnel or the equipment to do effective work.

Usually the township road engineer was not an engineer at all, but a farmer or other citizen without technical training who for one reason or another was deemed to be suited for highway administration. Exceptionally some vigorous man with hard common sense and a natural aptitude for construction would hold the job for a series of years. Then the dirt would fly and some creditable roads would be built, but such exceptions merely emphasized the low level of the average standard.

The same cause—the small size and financial weakness of the township unit—which prevented the hiring of first class men stood in the way of owning adequate equipment. A grader and two or three primitive drags were the extent of road machinery that the average com-

mission could hope to possess and these, reinforced now and then by farm tools and horses, were more than enough to do the work that was thought necessary.

Nor were highway payrolls handled with the greatest efficiency; right from the start they were considered a good means for the distribution of varying degrees of relief. In the early days even well-to-do farmers were accustomed to "working out" their highway taxes and this practice naturally led to giving road jobs to neighbors who were a little pressed for money. It was only a short step from this practice to the employment of the township road commission as a regular agency for poor relief. Unquestionably there is a sizable amount of welfare expenditure of this kind hidden away under the guise of road costs.

Unquestionably, too, much of the failure of the township organization can be laid to the fact that so large a proportion of the highway funds went into the costly maintenance required to keep low type roads passable. But in this matter as in others pertaining to the old township management, it is impossible to assess blame accurately when in so many cases commission records were carelessly kept and the frequent shifting of funds make even the totals of actual road costs uncertain.

Under these circumstances it is not to be wondered at that when the counties took them over, they found the township roads in a sad state as compared with the county systems. At the same time it must not be forgotten that these local roads, which on the whole served their time and people adequately, are now judged by standards which are foreign not only to their original purpose, but, in many instances, to their present use.

New problems arise

Needless to say, although the transfer of these roads has brought the expected relief to distressed local taxpayers, it also has had serious consequences for highway finances. Not only has the state highway department been stripped of three-fifths of its former revenues and the country road commissions presented with new and difficult problems, but the users of the local roads have been freed from former restraints upon their demands for highway improvement.

Rural residents who for decades contented themselves with the earth roads rather than assume the tax burdens which improving them entailed, are now insisting that they receive additional service. This is, no doubt, a very natural result of the new situation in which the recipient of the service has no direct part in the provision of the funds to pay for what he asks. Nevertheless, when this changed attitude affects nearly three-quarters of the entire state mileage, it gives highway authorities something to think about.

There has been great, and I may say general, complaint from county road officials that the funds provided by the McNitt Act are insufficient to meet these demands for improvements. They assert that $4,000,000 when pro-rated to the certified township mileage, will pay for only the barest maintenance in the average county and will leave no surplus for betterments and construction. It is impossible, they say, to furnish better service with only two-thirds of the former funds.

Snow removal is another problem that has come with the township roads being taken over by the counties. The state highway department keeps its 9,000 miles of state trunk line highway open for wheel traffic during the winter and the county road commissions have made a practice of removing snow on their principal county roads. With these precedents the residents along former township roads are now asking that more and more of the purely local roads be kept free of snow.

However, I think that too much emphasis can be given to a comparison of the funds available for the local roads before and after they were brought into the county systems. Of greater importance is the amount of local road mileage which is really essential, the standard of construction and maintenance it warrants, and the inefficiencies of the old administration which can be eliminated by the new.

Counties build better

As an administrative unit the county is demonstrating its superiority to the township in many ways. Not only does its stronger financial position make possible the employment of better technical talent and more complete mechanical equipment, but the larger field of operation permits their more efficient use.

POSTPONEMENT OF IMPROVEMENT of such farm-to-farm roads as this is justified until the more heavily traveled routes have been brought up to standard.

COUNTING STATION, one of 26 being used by the Michigan state highway department to take a 24-hour record for a a full year, as a part of the highway planning survey in which 4,000 part time stations are cooperating to produce an accurate traffic picture of the state's 90,000 miles of local, county and state trunkline routes.

In counties where heavy concentrations of motor vehicle registration and local taxes furnish large amounts of revenue, a surprising percentage of the county roads have been given a blacktop, or, under heavy traffic, a concrete surface and a large mileage of local roads has been improved. In one of these more fortunately situated counties nearly 85 per cent of the local roads have a gravel or better than gravel surface.

In some counties which are, perhaps, more nearly representative, it has been found possible to correct the grade and spread gravel on a lesser mileage, leaving a considerable amount of needed culvert replacement for future programs. In still other counties with smaller financial resources or in which other conditions are less favorable, about all that has been attempted is the maintenance of

the local roads as they were taken over.

In general the counties' plans for improving the earth roads which have been added to their systems are similar, but progress made is by no means uniform and this difference in results indicates that further adjustments in administration and revenues are necessary. It is probable, for instance, that in some areas sparseness of population and meagerness of economic resources do not give adequate strength to the single-county organization and that the merging of two or even three counties for highway purposes would be advantageous.

Financing the question

When it comes to the question of financing local roads, there is great diversity of opinion not only as to what should be done but as to what is the trouble. Some assert that a proper division of present funds among the various highway agencies and areas would produce satisfactory results. Others, probably the majority, believe that lack of funds is the trouble and that the remedy is to be found in tapping new sources of revenue.

The former cite the distribution of the weight tax and the Horton Act priorities as examples of what they believe are injustices. The case for more highway revenue rests, with good reason, on the fact that no more of the state highway department's revenues can be diverted to the support of local roads without bringing trunkline construction to a standstill.

It is my view that any readjustment of revenues should be preceded by a careful consideration of three obvious, but often neglected, facts. They are: First, that the local roads are now an integral part of the county road systems to be cared for, not out of any special grant, but out of the general highway funds of the county; second, that, like the city streets, they are still entitled to some degree of support from local taxation; and, third, that the function and use of a local road has a direct bearing on the standard of improvement and maintenance which is practicable.

When these points have been given their full weight, the subject of other revenue may be taken up. But any redistribution of present revenues or any appeal for additional revenues must be made with a full knowledge of all the facts connected with the highways, the traffic that uses them, and the fiscal structure which pays for them. And that brings us to the highway planning survey.

Hope in planning survey

The thing that makes this survey, in my opinion, the most constructive step in the long development of public roads, is that it will give us for the first time a complete and accurate statistical picture of our problem.

The mileage and character of existing roads; the use of the roads; the volume and type of traffic; the sources of highway revenue; the place of highway finance in the general fiscal structure; the handling of these finances; these are all factors which are vital parts of every one of the questions which now trouble and divide the counsels of highway authorities.

The definite data which the survey will give about them will serve as the solid foundation for highway development during the next ten years. I believe it will be a decade of the most intelligent and lasting development in highway history.

I am not in any way pessimistic about the future of the local roads or of the highways in general under the new system of administration. The public likes the results of county management so far, and would not return to the old organization. It is manifestly a step in the right direction and there can be no thought of receding from what has been gained through centralizing responsibility. It should be welcomed and its development should be encouraged.

What must be done is to bring about the correction of the badly adjusted details, particularly those relating to revenues, which today handicap the operation of a vastly improved administrative set-up. The Michigan state highway department has confidence—and this confidence is shared, I believe, by a large majority of the county road authorities—that the highway planning survey will furnish a factual basis for this correction. That will clear the road to a better day not only for the local roads but for the whole highway system.

Timber Roof Trusses of 111-Ft. Span Placed by Crane After Assembly

Light lattice trusses for warehouse at Tacoma fabricated with ring connectors—Time saved by erection with columns attached

By N. S. Perkins
Civil Engineer,
Douglas Fir Plywood Association

THE REQUIREMENT of an unobstructed floor area in a warehouse built recently at Tacoma, Wash., led to the selection of a design using timber roof trusses. Split ring connectors, which give a strength two to six times that of ordinary types of framed timber joints, made it possible to develop strength of truss members so effectively that a relatively light lattice truss was adequate for the span of 111 ft. 10½ in., including provision for a 40-lb. live load on the roof. Added advantages were that this design used materials available locally, and only a very short time was required for erection. The warehouse was built for the Pacific Forest Industries which is the export association of the Douglas fir plywood industry.

The building is 300x113 ft. in plan, has an inside unobstructed clearance between columns of 110 ft. 7 in. and a clear height above the floor under the bottom of trusses of 14 ft. 3 in. A railroad siding extending into the building for a length of 200 ft. has a depressed track to bring the floor of cars level with the warehouse floor.

The structural frame consists of fourteen roof trusses spaced on 20-ft. centers, spanning 111 ft. 10½ in. and supported on built-up timber columns. The columns are anchored by angles and bolts to 12x14-in. sills extending the full length of the building and resting on 12x12-in. transverse girders. These 12x12's support the 4x12-in. floor stringers (carrying a 3-in. floor decking) and rest on short 12x12-in. posts. The posts in turn are supported on concrete pedestals 3½ ft. square under columns and 2 ft. square elsewhere. Concrete footings are spaced 10 ft. lengthwise of the building and 8 ft. transversely. The building is enclosed at sides and ends with V-rustic on 2x6-in. studs spaced 24 in.

The roof trusses are of the lattice type, designed with 6x14-in. purlins, a 2-in. roof decking and composition roofing, to carry a live load of 40 lb. per sq.ft. Both top and bottom chords of the trusses are made up of two 4x14's with diagonals as shown in Fig. 2. One system of diagonals (6x6's) was framed between the chord members, the other diagonals, framed outside the chord members, consist of two 3x6's except in the six center panels where 4x6's were used.

Two rows of longitudinal bracing, consisting of simple *T*-beam sections formed by bolting a 2x6-in. web to the bottom of a flat 2x12, were framed between each pair of bottom chords at the one-third points. The pair of trusses at each end of the warehouse and at the center were *X*-braced with three sets of ⅝-in. tie rods with turnbuckle adjustment.

All joints were made with 4-in. split ring connectors, with standard spacing and margins at ends and edges in accordance with recommendations from

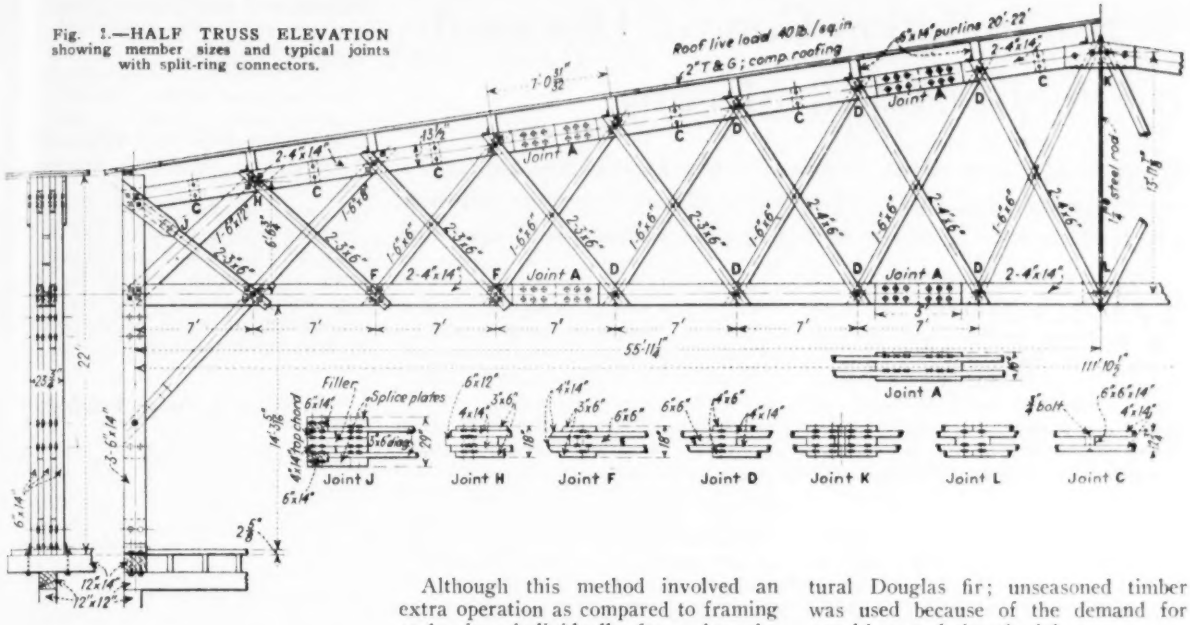


Fig. 1.—HALF TRUSS ELEVATION showing member sizes and typical joints with split-ring connectors.

the manufacturer's engineers. The bolts through the rings are ¾ in. in diameter. Allowance was made for camber by increasing the length of top chord members ⅛ in. per panel over the length required.

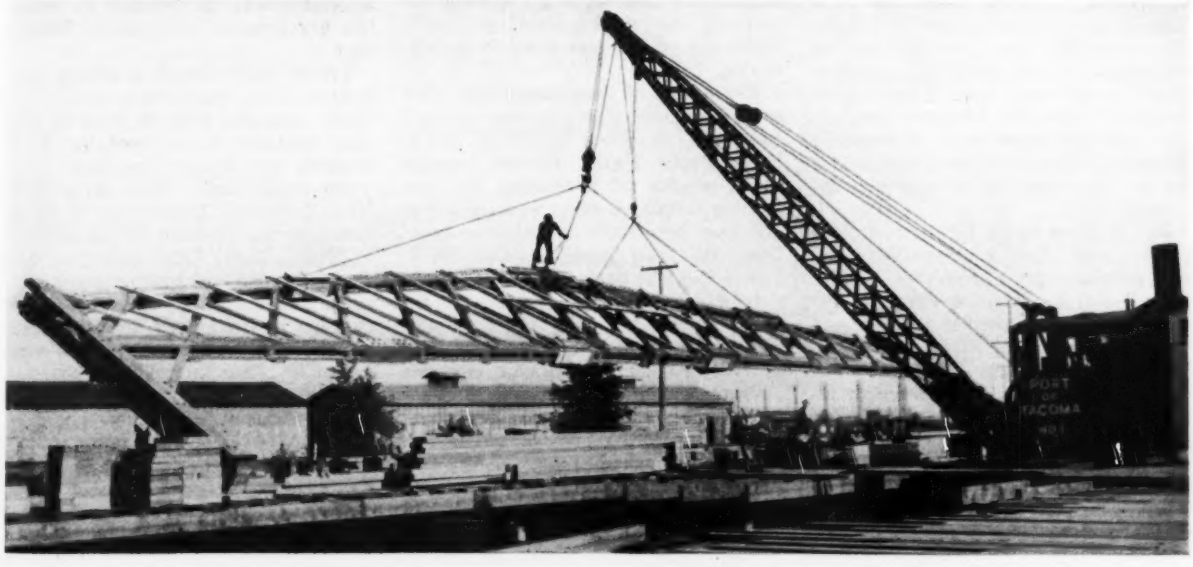
Trusses and columns were prefabricated at the site using patterns cut from 1-in. lumber. After the members had been cut to size each truss was assembled in a horizontal plane and held in place by toenailing while bolt holes were bored. The truss was then taken apart to cut the grooves, one-half in each of the contact surfaces, for the split-ring connectors. After the rings were inserted the truss was reassembled and bolted together with a single connecting bolt through each set of rings.

Although this method involved an extra operation as compared to framing each piece individually from shop details, it was considered necessary in this case because unseasoned timber was used. Unequal shrinkage of timber dried down from a high moisture content to about 15 per cent moisture content, as was contemplated in this structure, tends to decrease the width of the grooves in the timber and sometimes occasions difficulty in installation of rings in the grooves. The additional cost of field fabrication on this job, as compared with the estimated cost of shop fabrication, was about 30 per cent, making the total cost of labor for both fabrication and erection of trusses slightly less than $40 per thousand feet of lumber. The timber used was structural Douglas fir; unseasoned timber was used because of the demand for speed in completing the job.

As the trusses and connected columns were assembled, each was raised bodily to place by a 20-ton locomotive crane using a five-point suspension. The fourteen truss units were fabricated and erected in twelve working days. Five weeks after erection check levels taken along the lower edge of the bottom chords showed a camber of 1 to 1⅜ in.

Design for the structure was made by S. J. Selden, consulting engineer, Tacoma, Wash. George W. Osgood, general manager and chief engineer, Port of Tacoma, was in charge of the work; F. B. Weick was assistant engineer and A. W. Carlson was superintendent of construction. Ring connectors were supplied by A. C. Horner, Timber Engineering Co., San Francisco.

Fig. 2.—ERECTING TIMBER TRUSS and attached columns by a locomotive crane using a 5-point suspension.



Water Pollution Control Discussed At Public Health Meeting

Engineering session of the American Public Health Association features papers on legislative and technical phases of stream pollution, water purification practice and activated sludge plant operation

VARIOUS ASPECTS of water pollution control ranging from stream degradation to defective plumbing and means for improving water purification technique were presented in sessions devoted to public health engineering at the 65th annual meeting of the American Public Health Association, held at New Orleans on October 20-23.

In a paper by R. E. Tarbett, senior engineer, U. S. Public Health Service, the Lonergan Bill (S-3958) now in the Senate, and the Vinson Bill (HR-12764) in the House of Representatives, were mentioned as evidence of a growing sentiment in favor of federal water pollution control. The Lonergan bill proposes control over stream pollution by the federal government and reflects the views of sportsmen and conservationists. The Vinson bill provides for technical cooperation of the U. S. Public Health Service with existing state authorities. Both bills make provision for federal financial aid in the form of loans and grants, and the speaker stated that this would naturally give the federal government some control as to policy.

Tri-State compact progress

C. A. Holmquist, New York state department of health, outlined the various legislative and other steps incident to the formation of the interstate contact between New York, New Jersey and Connecticut for the control of pollution of the waters in and about the New York City metropolitan area. All legislative steps have now been taken and the administrative and technical organization is under way. One of the biggest problems before the interstate commission is a determination of an equitable balance of effort and expenditure among the several states and communities involved.

In a progress report for the committee on distillery waste, Clarence W. Klassen, state sanitary engineer of Illinois, pointed out the potential effect of this waste on the pollution of streams, and stated that by the use of dewatering devices not only could liquid waste be eliminated, but the dried products remaining could be sold as cattle food for about $40 per ton.

Dr. L. M. Fisher, U. S. Public Health Service, presented a report on behalf of the committee on shellfish, dealing particularly with water storage and conditioning and cleansing of shellfish. The paper indicated the practicability of removing shellfish from moderately polluted waters to clean waters for their purification prior to marketing, and also mentioned a method of treatment in tanks fed by clean chlorinated water. When using the latter scheme it is important to effect final removal of all chlorine, preferably with sodium thiosulphate. At present there is a municipal oyster cleaning plant at Newburyport, Mass., a privately owned plant at Plymouth, Mass., and an experimental plant operated by the Virginia health department near Norfolk. A list of known disease outbreaks due to polluted oysters was given, and it was recommended that sewage treatment along the coast should be predicated upon giving reasonable protection to oyster beds.

Water treatment

In a paper on chloramines in water purification, A. E. Griffin (Wallace & Tiernan Co.) emphasized the importance of considering the free ammonia in water and establishing the ratio between applied ammonia and applied chlorine. This ratio has a wide variation of from 1 to 3 to 1 to 12. In commenting on the so-called ammonia demand of the water, it was indicated that there was no noticeable absorption of ammonia by water if added not over ten minutes before applying chlorine. There are many phenomena in connection with the use of ammonia in chlorine which are not understood, the speaker said, and additional observation and research are desirable.

The design of institutional and other small treatment plants to meet unusual conditions, described by F. R. Shaw, U. S. Public Health Service, brought out a number of interesting facts regarding simple but effective installations that have been made on Indian reservations, for coast guard stations, lighthouses and lake boats.

In a report which reveiwed the typhoid outbreaks in the United States and Canada during the period from 1930 to 1935, Arthur E. Gorman, engineer of water purification, Chicago, brought up to date studies that have been continued since 1920. While the figures were not complete, it was shown that some improvement had taken place over the previous decade. Among frequent causes of typhoid outbreaks were listed: Polluted well water supplies, improperly operated purification plants and defective plumbing. The report called pointed attention to outbreaks other than typhoid fever, including amoebic dysentery, bacillary dysentery, jaundice, and intestinal disturbances due apparently to decomposition products in purified water.

Progress in the control of defective plumbing was reported by Joel I. Connolly, who stated that the University of Iowa is instituting research on plumbing, with particular reference to the possibilities of water supply pollution by defective installations.

Activated sludge bulking

Langdon Pearse, engineer of the Sanitary District of Chicago and chairman of the committee on sewage disposal, presented a report dealing with bulking of sludge in the activated sludge process. He stated that experiences and opinions are frequently dissimilar and contradictory and no definite recommendations could be made other than that the subject should be given further study and investigation covering: (1) Operating irregularities affecting air volume, sewage volume, aeration period, solid content of mixed liquid, and settling rate; (2) changes in sewage composition, particularly the mineral and volatile content of suspended matter; (3) presence of trade waste; (4) relation of carbon and nitrogen in the sewage and sludge; (5) bacteria removal by the process; (6) microscopic and chemical examination of the activated sludge.

The report referred to two kinds of bulking, namely, (1) a false bulking, and (2) a real bulking. The former occurs with good activated sludge and generally results from faulty operation, particularly in the matter of permitting too much return sludge. True bulking relates to a sludge that does not floculate and does not settle. This bulking is associated with an infection by thread-like organization, particularly *Sphaerotilus*.

Trends and progress in sewage treatment in Iowa, where there are now 238 plants compared with 97 prior to 1916, were outlined in a paper by A. H. Weiters, state sanitary engineer.

Sol Pincus and Arthur Stein of the New York City Department of Health indicated the evidence of air pollution in New York City with statistical material on coal consumption and amount of smoke, fumes, dust and organisms in air. They discussed measurement of ultra-violet rays as a measure of injurious air pollution that may increase the tendency to rickets, tuberculosis and lowered vitality.

The following officers were elected in the public health engineering section for the ensuing year: Gordon M. Fair, chairman, J. I. Connolly, vice-chairman, Roy J. Morton, secretary.

Letters to the Editor

Cloudburst Flood Formula

Sir—The *Engineering News-Record* of October 1, 1936, p. 474 contains an article by I. Gutmann in which he presents a "New Cloudburst Flood Formula." The proposed formula was based on records of floods which did not include many available published records, notably Table 2 accompanying the paper by C. S. Jarvis, on "Flood Flow Characteristics" and published in *Transactions* of the A.S.C.E., Vol. 89, 1926. Use of this table would have given many points far above the line plotted to show the straight line relationship of the proposed formula. In addition, reference to recent U. S. Geological Survey water supply papers would have disclosed many other data that would plot far above the line.

The accompanying table gives data contained in U. S. Geological Survey Paper No. 748, and data tabulated by the Water Resources Branch of the Geological Survey cooperating with the Texas State Board of Water Engineers, concerning flood flows in Texas.

These data plotted on logarithmic paper indicate a maximum flow to be expected of six times that shown by:

$$q = \frac{100{,}000}{37 + A}$$

It will be seen that the formula, if applicable at all, would apply equally as well to areas up to several thousand square miles.

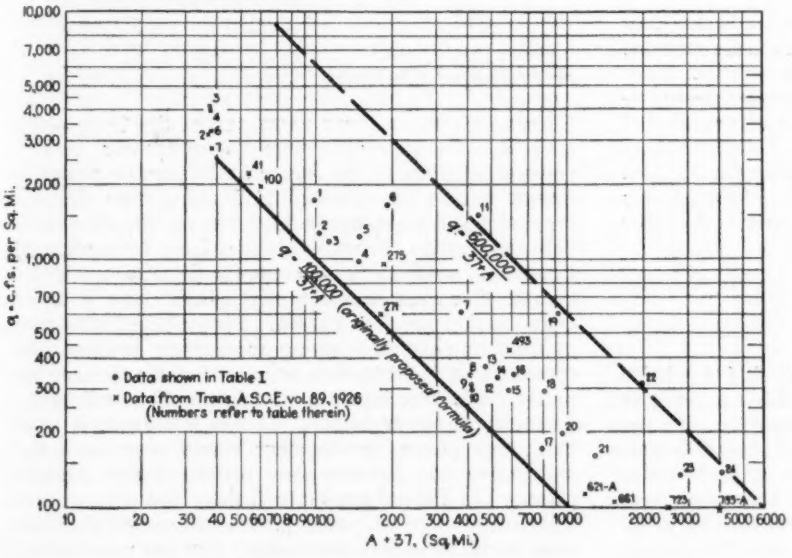
It is the opinion of the writers that maximum flood flows for this geological era and climatic age are more or less confined to certain areas; there are certain areas in Texas where these maxima may occur and other areas where such maxima would never be expected to occur unless a material change in present climatic conditions took place.

Certainly the formula presented gives flows far below those actually experienced in Texas—so far below that it has no value for designing spillways and other flood structures. In fact, the use of this formula would sooner or later lead to disaster.

Austin, Tex.
Oct. 19, 1936

JOHN W. PRITCHETT,
GEORGE C. COMMONS,
Texas Board of Water Engineers.

RUNOFF DATA PLOTTED from the accompanying table of discharges in Texas indicates a maximum expected flow six times greater than that shown in the originally proposed formula.


q - c.f.s. per Sq. Mi.
A + 37, (Sq. Mi.)
q = 600,000 / 37+A
q = 100,000 / 37+A (originally proposed formula)
• Data shown in Table I
× Data from Trans. A.S.C.E. vol. 89, 1926 (Numbers refer to table therein)

Bridge Tower Sections

In the excellent article entitled "Designing Bridge Towers 700 ft. High" by Clifford E. Paine, (ENR, Oct. 8, 1936, p. 497) there is shown a table of comparison of the Golden Gate Bridge towers with the towers of other notable suspension bridges.

At the bottom of the table you give the sectional area in each case near the tower base. These figures are correct except that for the George Washington Bridge towers the section should be 5735 sq.in. instead of 5000 sq.in. as given. The sections near the base of the tower shafts do not, however, offer to the engineer a true comparison of the tower strength and magnitude. A more correct comparison is furnished by the average sectional area of the respective shafts. The average sectional area of a shaft of the Golden Gate Bridge towers is 6180 sq.in., of the George Washington Bridge 5150 sq.in., of the Transbay Bridge 2447 sq.in. and of the Philadelphia-Camden Bridge 2460 sq.in. The divergence in the George Washington Bridge towers is due to the different type of construction.

New York, N. Y.
Oct. 22, 1936

LEON S. MOISSEIFF,
Consulting Engineer.

MAXIMUM MEASURED PEAK DISCHARGES IN TEXAS

No.	Stream and Location	Date	Drainage Area in Sq. Mi.	Peak Discharge in Sec.-Ft.	Discharge in Sec.-Ft. Per Sq. Mi.	Reference
1.	East Fork James' River at Old Noxville, Tex.	7- 1-32	60.8	105,000	1730	(b)
2.	South Guadalupe, 8 miles above Hunt, Tex.	7- 1-32	65.3	84,300	1290	(b)
3.	East Fork of Frio River, 7 miles above Leakey, Tex.	7- 1-32	75.0	89,500	1190	(b)
4.	North Guadalupe, 8.5 miles above Hunt, Tex.	7- 1-32	110	108,000	982	(b)
5.	Johnson Creek near Fish Hatchery, Kerr Co., Tex.	7- 2-32	111	138,000	1240	(b)
6.	Seco Creek, 7 miles above D'Hanis, Texas	5-31-35	153	254,000	1660	(b)
7.	Guadalupe River above Ingram, Tex.	7- 1-32	336	206,000	613	(b)
8.	Frio River at Rio Frio, Tex.	7- 1-32	371	128,000	345	(b)
9.	Tenaha Creek near Joaquin	7-24-33	374	117,000	313	(a)
10.	Blanco at Wimberly	5-28-29	378	113,000	299	(a)
11.	West Nueces River, 28 miles above Brackettville	6-14-35	402	612,000	1520	(b)
12.	Blanco River at Austin, San Marcos Highway Crossing	5-28-29	429	139,000	324	(b)
13.	San Gabriel River near Georgetown	9-10-21	431	160,000	371	(b)
14.	Frio River at Concan	7- 1-32	485	162,000	334	(a)
15.	South Llano, 30 miles above Junction	6-14-35	540	160,000	296	(b)
16.	Guadalupe at Kerrville	7- 1-32	570	196,000	344	(b)
17.	Dry Devils River, 1 mile above mouth, Val Verde County	9- 1-32	748	129,000	172	(b)
18.	Nueces River at Laguna	9-21-23	764	226,000	296	(b)
19.	West Nueces, 8 miles above Cline	6-14-35	880	536,000	609	(b)
20.	Guadalupe near Comfort	7- 2-32	916	182,000	199	(b)
21.	San Marcos at Ottine	5-29-29	1249	202,000	162	(b)
22.	Nueces near Uvalde	6-14-35	1930	616,000	319	(b)
23.	Devils River near Juno	9- 1-32	2733	370,000	135	(b)
24.	Devils River near Del Rio	9- 1-32	4004	558,000	139	(b)

(a) Water Supply Paper No. 748.
(b) U.S.G.S. List of Floods in Texas, 1936.

ENGINEERING NEWS-RECORD

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Editorial Offices at 330 West 42d Street, New York

November 5, 1936

Unsafe Dam Design

THE MULTIPLE-ARCH DAM is a relatively new type of structure, and experience with the design is correspondingly limited. One might therefore expect to find dams of this type to be over-conservative in their proportioning rather than the opposite. Yet the Hodges Dam article in this issue (p. 644) records the second instance within a few months of urgently needed repairs to such a dam; the case of Lake Pleasant Dam was the other (*ENR* June 18, 1936, p. 867). It seems that the caution appropriate to a new field of design was not always observed in building multiple-arch dams. Hodges Dam, a pioneer that held the record for height when it was built some 20 years ago, long since has yielded this position—twice its height has been attained. But it is to be hoped that it never will be surpassed in the matter of frailty and instability, defects that will soon be made a matter of the past by completion of the rehabilitation work now in progress. This strengthening, by the way, is indicative of how effective have been recent lessons from dam failures and earthquake shocks. Cracks in the buttresses of Hodges Dam first drew attention to a weakened and perhaps dangerous condition, but the lack of stability, which later was concluded to be the more serious deficiency, was not thoroughly analyzed until after the Long Beach earthquake of three years ago emphasized the seismic risk. Out of our catastrophes thus are coming safer designs and higher construction standards.

New Practices

ROAD PLANNERS and road builders will find food for thought in the extension of federal influence revealed by the Bureau of Public Roads' latest statistics. In the year just closed (July 1935 to June 1936) federal money, besides contributing to the construction of more miles of road than ever before, extended into classes of road work that by long tradition have been considered to lie outside the federal sphere: secondary roads, city streets, grade-crossing protection, roadside beautification and planning surveys. The question of how far these new activities are sound need not now be discussed, for they will probably continue. Few people would approve of reducing them, and since it is the local governments and their Congressmen that clamored for the new kind of federal aid there is little chance that it will soon be withdrawn. Therefore it is important to consider how it will affect state and local highway thinking. The evidence indicates that it will do much to control individual practices, as has already been realized by cities whose street construction has received federal and state aid. Too frequently in the last year city authorities have found that their practices did not come up to the requirements of the cooperating authority, that they had not been kept up to date. The outmoded local practices naturally had to give way under federal control. Similar readjustment is sure to be required in the other fields which federal money participation is entering. It should be anticipated by reviewing present practices in engineering and management and bringing them abreast of highest current standards.

Reducing Dead Weight

CONSTRUCTION of a number of cellular reinforced-concrete bridges in the Northwest is an interesting development. Although not new, the hollow design is relatively rare as compared to solid-section design of concrete structures. Cellular construction is widely used in piers and abutments, but rarely in girders or arch ribs, though often its advantages are greater in such members than in foundations. The greatly decreased dead weight, smaller bending moments, longer spans and fewer piers of cellular superstructures are advantages that should appeal to the concrete designer. In the Buckley overpass, illustrated in this issue, use of the so-called "banana crates" is a step toward simplifying hollow construction —simplicity of formwork is of course a prime essential if departure from solid section is to justify itself. In Europe, where cellular construction has found much use, a large stock of design and service information has been accumulated. The Washington bridges indicate that utilization of these experience records in conjunction with native resourcefulness in design and field methods offers fruitful opportunities in this country.

A Hopeful Outlook

COMPARING THE LATEST ESTIMATE of the Oregon Planning Board's advisory committee on power with previous discussions of the future of Bonneville power, one cannot fail to be surprised at learning that the entire output of the big plant is likely to be absorbed in less than ten years. So many charges have been made that Bonneville and other current projects are futuristic dreams that most people firmly believe there is no adequate market for their output. Such a belief is of course undeniably right if nothing more than present power consumption is taken into account, but the Oregon committee finds that increase of consumption will take up Bonneville's power in full. If this is correct, it follows that other power development would soon have to be undertaken but for the construction of the Bonneville plant. The federal project will therefore prevent a considerable amount of power plant construction that otherwise would have been necessary. But ten years after all is a short time. If the committee's estimates can be accepted as sound, it is not out of reason to think that Bonneville, and perhaps some of the other current power projects, will yet prove to fit into a constructive development plan.

Industrial Waste Surveys

PROMOTION AND PLANNING of stream-cleanup programs are at present severely handicapped by insufficient knowledge of pollution by industrial wastes. A primary requirement therefore is the collection of basic data that will make it possible to evaluate the degree and kind of industrial pollution. This task is complicated by the number and distribution of industrial enterprises and even more by the variation in the polluting power of the wastes produced within a single industry. Measures of

domestic sewage pollution in a watershed or region are generally available, but comprehensive data on the effect of industrial wastes on streams are still meager. For this reason the statewide survey of industrial wastes recently completed in New Jersey and reported on p. 636 of this issue is a real contribution to progress. It is noteworthy in scope and content of its factual information; it is even more noteworthy for its method of presenting analytical results on the basis of "employee units." This latter form of representation offers a simple and equitable method of making comparisons and estimates. The adoption of a standard unit such as this is certain to clear the way for more effective attack on stream pollution by providing quantitative yardsticks applicable to the highly complex field of industrial waste surveys.

Merit Recognized

NEW HONOR was given to the old but frequently neglected doctrine that public service is a public trust when the Mayor of New York last week appointed Joseph Goodman, who in 35 years of service in the city's department of water supply, gas and electricity had risen from transitman to chief engineer, to the post of commissioner of that department. In so doing he broke a precedent of long standing, for until that moment the position of commissioner had been a matter of political patronage. Mr. Goodman's appointment made it a matter of service recognition. The Mayor's action was an emphatic stroke for adoption of the career-service principle in municipal administration.

Public service stands in urgent need of this principle. It needs to place demonstrated merit above personal whim and political claims if it expects to be on even terms with private business. For in the main private business enterprise of today follows the policy of developing its administrative personnel by training in the service and by advancement on merit. Generations of experience, and long trial of nepotism and personal preferment, taught it that efficiency of service is compatible only with recognition of the assets of technical skill and breadth of knowledge born of rich experience.

The public service demands no less sound organization practices than private business. Its functions are the same, its responsibilities even greater. Yet public service is all too little conscious of the importance of a constructive personnel policy. Its shortsightedness has the result that many able men turn away from seeking a career in government service, and those already engaged in it find little incentive to real effort. The federal government has often given encouragement to the principle of career service, but state and municipal governments have been slow to follow. The Goodman appointment therefore stands as a rare exception. We are optimistic enough however, to look upon it as a significant symbol of progress in municipal administration.

In its technical services public administration has moved steadily upward to a high level, perhaps because the demands of these services are inherently so compelling as to encourage ability and discourage incompetence. The frequent rapine of state highway organizations by commercialized politics is the exception that but proves the rule. Administrative service, however, largely continues in the dark realm of politics and preference. And this is daily a matter of greater concern as the responsibility imposed on the administrative services increases. But most of all the administration of technical departments such as water service stands in need of technical merit proven by service, for the work of even the ablest staff can be rendered ineffective by faulty executive decisions.

The years are gradually bringing some progress here. Bit by bit the movement to make merit and fitness prevail in public administration is going forward. Mayor La Guardia's action can hardly fail to give the movement impetus.

Making Sure of Fundamentals

LAST WEEK we commented on the President's challenge to the engineering colleges to extend their curricula into the social and economic field, and on Dr. Karl T. Compton's frank reply. With one voice, in fact, the leaders of technical education answer that the need for broadening has had their thought for many years and is being met as fully as the primary claim of training in the engineering sciences permits. Should this answer leave any mental doubt, the doubt is removed by the announcement of the college accrediting which the Engineers Council for Professional Development has carried on. The scrutiny of the colleges on which the accrediting was based is precisely the kind of self-criticism that will guard technical education against obsolescence.

Of course this scrutiny is not a one-time job, but like all other inspection requires periodic repetition as a check on maintenance. Regularly repeated it may be expected to throw light on operating procedure, in this case the effectiveness of the teaching itself. Even the first report on accrediting suggests that the examiners found it quite as necessary to audit the teachers as to review curricula and time schedules. This audit may prove to be the most valuable element of the accrediting, since the teacher is more important than the text.

In one point, however, college education is unique. Most other matters that are subject to inspection involve present standards and requirements. Engineering education, on the contrary, deals with the requirements of ten or twenty years ahead. Today's college students represent the body of the profession a generation hence, and what they acquire in the teaching halls of today determines how well the engineers of tomorrow will serve the world of their day. It is this that makes the accrediting work a task of exceptional responsibility, one that calls for profound insight and understanding. With men of the caliber now enlisted in the work these qualities are assured, and the accrediting service may be counted on to do its part in building a strong, worthy profession.

Underlying the problem is the all-important fact that it is not education *per se* that is in question, but engineering education. This means that the teaching of the fundamentals of engineering science and method is primary, and that all else must yield. The engineering college does not exist to train lawyers, or corporation executives, or social service workers, or expert accountants; it exists to train engineers. If in doing this it can also equip the nascent engineers with a general perspective of these related functions, their purposes and principles, the gain will be large. But only if the students are first trained as engineers. It is in this light that the firm adherence to principle revealed in the letters of the technical college heads is vital and gratifying.

CURRENT NEWS

Bonneville Power All in Use by 1945

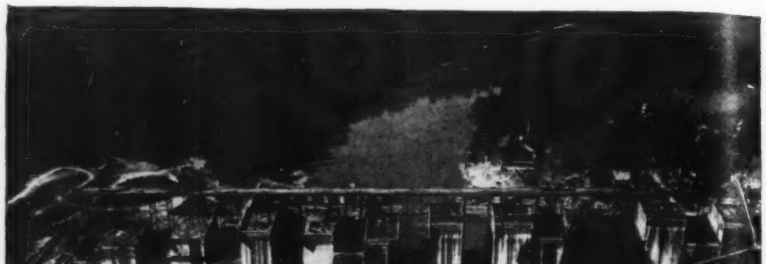
Oregon Planning Board states that growth of consumption indicates Bonneville power can all be used

All of Oregon's share of the ultimate capacity of the Bonneville power project on the Columbia River will be needed to supply the demand in Oregon before 1945, according to a forecast in the latest report of the advisory committee on power of the Oregon State Planning Board. This estimate is based on the assumption that Bonneville power will be divided equally between the states of Oregon and Washington, giving 216,000 kw. as the full capacity available for use in Oregon, since Bonneville will generate 432,000 kw.

In the report, entitled "Use of Electricity in Oregon with Forecast of Future Demands," the power use by different classes of customers has been plotted from 1923 to 1935 and extrapolated to 1945. The figures indicate that by that year there will be a total annual demand for 1,656,000,000 kw.-hr., about double the 1935 use. This will require a generating capacity of 817,000 kw., the report states. The report lists the present installed capacity as 362,843 kw., of which 190,000 is hydroelectric. The 1945 demand will absorb the half of the ultimate Bonneville capacity assumed to be allocated to Oregon and will require an additional 100,000 kw. of generating capacity in the Columbia Basin area near Bonneville and 200,000 kw. in the state outside of the area that can be served from Bonneville.

The report recommends that half of the Bonneville power be reserved for domestic, public, and commercial uses, and half be made available for industry. This recommendation is based upon the fact, disclosed by the studies, that half of the present consumption of power and half of the probable consumption in 1945 is provided by domestic and commercial users.

It is further recommended that a considerable block of Bonneville power be made available for power-using industries at the lowest possible switchboard rate, in order that it might be possible to "create economic opportunity for further development and use of Oregon's large potential hydroelectric power resources."



CONCRETE IN TYGART DAM NEARS THE TOP

NEARLY 125,000 cu. yd. of concrete was placed in the Tygart River Dam, near Grafton, W. Va., in October, bringing the total to date up to 940,000 cu. yd. The gravity-section dam, 1,900 ft. long and 225 ft. high will require 1,241,000 cu. yd. It is being built by the U. S. Engineer Department as one of a series of flood-control projects for the Pittsburgh area.

The three large whirley cranes placing the concrete are now working from the third and top lift of a steel trestle built up within the dam. Concrete is furnished by a central plant containing four 4-yd. mixers, the total capacity of the plant being rated at 5,280 cu. yd. daily. From present indications the entire project will be completed by the middle of next summer. Frederick Snare Corp. of New York, is the contractor.

PWA Housing Project Approved For Lackawanna, N. Y.

The housing division of PWA has made an allotment of $1,500,000 for a low-cost housing project at Lackawanna, N.Y. The allotment is conditioned upon the acquisition of a suitable site in the city at a justifiable price.

The project was organized and the allotment requested by the Lackawanna city housing authority, which states that there is an acute housing shortage in that city as a result of the revival of industrial activity. The authority blames an unusual prevalence of tuberculosis on the bad condition of housing in the city.

The project is financed upon the same basis as other PWA low rent housing projects, with 45 per cent of the allotment as a grant, the remaining 55 per cent to be repaid from rents over a long period of years.

Price-Fixing Charged On Valves and Hydrants

The Federal Trade Commission has issued complaints, charging price-fixing, against 34 manufacturers of water gate-valves, hydrants, fittings, and similar articles, sold principally to municipalities and governmental agencies. The manufacturers are all members of the water-works valve and hydrants group, of the Valve & Fittings Institute, of New York City, which is also named in the complaint.

It is charged that in December, 1935, the manufacturers entered into a price fixing combination setting up zones in which uniform discounts and enhanced uniform prices were fixed. They are given until Dec. 4 to show cause why a cease and desist order should not be issued against these practices.

Arizona Urged To Ratify Pact

State attorney recommends Arizona ratify Colorado River Compact, saying litigation is unnecessary

The state attorney-general and special attorneys employed by the Arizona Colorado River Commission recommended in a report filed Oct. 24 that Arizona ratify the Colorado River Compact and suspend litigation over the waters of the river.

The attorneys said, in a report submitted to the commission, that "whether Arizona likes it or not, the Colorado River Compact has, in effect, become the law of the stream" and determines the future use of its waters.

"In our opinion no further litigation is necessary or advisable to fix and establish Arizona's rights in the river," the report continues; "Arizona will never, from a practical standpoint, be able to fully utilize her share of the waters of the Colorado River until she has ratified the Colorado River Compact."

H. A. Elliott, a member of the commission, stated that the report did not represent the opinion of the commission and was filed merely as a formality.

On Oct. 23 the services of James F. Moore, who has been acting as chief special assistant to the attorney-general, were terminated.

Pair of Career Men Get High Posts

New commissioner and deputy chief engineer of New York City water department have risen from ranks

With the appointment of Joseph Goodman as commissioner of the New York Department of Water Supply, Gas and Electricity, and Patrick Quilty as deputy chief engineer, reported in these pages last week, two municipal career men, each with more than 30 years continuous service, advanced to executive positions. The promotion of Mr. Goodman from chief engineer to commissioner, to succeed the late Thomas W. Hammond, is a departure from usual custom in the department and comes about as part of Mayor LaGuardia's policy that all city departments doing technical work should be headed by civil service commissioners. Before the commissioner's office can be placed under civil service status, however, a special ruling will be necessary, either by charter modification or legislative action.

Mr. Goodman came to the department as

Joseph Goodman
Commissioner

a transit-man in 1901, three years after his graduation from the Columbia University School of Mines. In 1904 he became assistant engineer and was in charge of construction of distribution and pumping facilities in the Brooklyn area, where water was then obtained entirely from ground water. Forging steadily forward, he became division engineer in 1910, and in this position was responsible for the design and extension of system improvements throughout the city. Beginning in 1934 he occupied, in rapid succession, the positions of deputy chief, acting chief, and chief engineer until his appointment as commissioner last week. He holds membership in the American Society of Civil Engineers and the American Water Works Association.

Reflecting on changes that had occurred in his thirty-five years association with the department, Mr. Goodman pointed out that since 1900 water consumption demand in New York had risen from 370 to 985 m.g.d., but population had only slightly more than doubled itself.

Patrick Quilty, the new deputy chief engineer, has been in the employ of the city for 32 years. He started with the topographical bureau in Staten Island in 1904 and two years later was transferred to the water department. In 1920 he became an assistant engineer, and for a time was engineer of a special bureau engaged in subway conduit construction. From 1927 until his present promotion he was engineer in charge of water supply for the borough of Manhattan.

Mr. Quilty received his early education in Ireland and, after coming to this country, continued his engineering studies at Cooper Union to graduate in 1898. He

Patrick Quilty
Deputy Chief Engineer

worked in the business department of Park & Tilford Co. before starting his engineering career.

From 1899 until 1932 Mr. Quilty was a member of the night school faculty of Cooper Union where he taught mathematics. He holds membership in the Mathematical Association of America and the American Water Works Association.

Subway Contract Awarded

Contract for construction of the section of the Sixth Ave. subway in New York City between 40th and 34th Sts. has been awarded to the Park (Rosoff) Contracting Corp., by the Board of Transportation on its low bid of $7,835,000.

On Sept. 4 the Board of Transportation rejected all the bids received from the original advertisement for this section. In that first group of bids, J. F. Cogan was low with a bid of $6,492,626; the Park Contracting Corp. was second with a bid of $8,231,273.

Five bids were received by the New York City Board of Transportation for construction of the section of the Sixth Ave. subway between 47th and 53d Sts. George H. Flinn Corp. was low at $4,615,476. The other bidders were Arthur A. Johnson-Necaro Corp., $5,361,000; Underpinning & Foundation Co., Inc., $6,144,000; Rogers & Hagerty, Inc., $6,172,000; and Spencer, White & Prentis, Inc., $6,238,447. Bids for the subway section between 18th and 27th Sts. are expected to be opened about Dec. 15. The only remaining section will then be that from 18th St. to 9th St. At 9th St. the subway will join the Eighth Ave. line.

Port Authority Pay Held Not Taxable

Board of Tax Appeals holds Port of New York Authority is a state agency, its bonds and payrolls tax-exempt

Pay of employees of the Port of New York Authority was held not to be subject to federal taxation in a decision handed down on Oct. 28 by the Board of Tax Appeals in Washington. The board held that the authority is an agency of the states of New York and New Jersey for the purpose of improving and developing the port facilities.

The federal government had contended that salaries paid by the authority were taxable because the authority operated terminal and other facilities at a profit. The board held, however, that the profit-making aspect of the authority's operations was merely incidental to the major purpose of developing the port.

The board also held that bonds of the authority were not taxable by the states of New York and New Jersey. It was held that, in general, the authority should be regarded as "the municipal corporate instrumentality of the state for the purpose of developing the port and effectuating the pledge of the states in the compact."

PWA Allocates Eight Million

The PWA has allotted grants of $7,418,000 for 130 projects with an estimated construction cost of $16,455,000. Twenty-four of these projects involved loans totaling $989,000. The grants are on the basis of 45 per cent of the cost of the project.

Most of the grants are for less than $50,000. The largest is a grant of $414,000 to the Municipal University of Omaha, Neb. for the construction of university buildings and improvement of the campus at a cost of $920,000. A grant of $405,000 to the city of Lansing, Mich. provides for the construction, at a cost of $900,000, of a sewage and garbage disposal system. The Department of Public Docks of Portland, Ore. has received a grant of $391,000 for the rehabilitation, improvement and enlargement of terminal No. 1 in Portland harbor.

Federal Funds Allotted For Flood-Damaged Bridges

The President, on Oct. 24, allocated $810,927 from the funds of the Emergency Relief Act of 1936 to reconstruct bridges damaged or destroyed during the 1936 floods in New Hampshire, Pennsylvania, Connecticut and Massachusetts.

New Hampshire received an allocation of $61,500, to which sponsors agreed to contribute an additional $20,500, for six bridges. Pennsylvania received $135,686, for a bridge over Stony Creek at Johnstown and a bridge over the Kiskimintas River at Leechburg Boro. Connecticut received $32,350, sponsors contributing $4,650, for six bridges. Massachusetts was granted $581,391 for 30 bridges.

Aerial Explorations Photo.

SLUM CLEARANCE MAKES ITS IMPRINT ON TWELVE BROOKLYN BLOCKS

LARGEST of the PWA slum clearance and housing projects is Ten Eyck houses in the Williamsburg section of Brooklyn, N. Y. Twelve city blocks of 24 acres are being transformed into four super-blocks by removing the cross streets, and 14-story apartment houses, housing 1,615 families, will be erected on ten of the former blocks. The two other blocks will accommodate a new school, which the City of New York has just completed, and a playground.

Most of the foundations are finished and ready for superstructure construction, as may be seen in the air view. The superstructures, of reinforced concrete, are characterized by a special flat slab framing in which column capitals are eliminated by the use of embedded structural steel column heads.

R. H. Shreve is chief architect of the associated group that designed Ten Eyck houses. George E. Strehan is structural consultant. The foundation contract is held by Wallin Concrete Corp. and superstructure by Starrett Bros. and Eken, Inc.

Diversion of Colorado River Effected at Parker Dam

Diversion of the Colorado River through two tunnels at the site of Parker Dam has been successfully effected. Parker Dam, 155 miles downstream from Boulder Dam, is being constructed to re-regulate the river, generate hydroelectric power, and to divert water into the aqueduct of the Metropolitan Water District of Southern California. Parker Dam will be a 340-ft. concrete arch structure.

The river is diverted through two tunnels 29 ft. in diameter and 1730 ft. long, drilled through the mountain on the Arizona side of the river. The river will flow through these tunnels for about two years before it is returned to its normal channel to fill the reservoir and flow over the completed crest of the dam. At the end of their service as diversion tunnels, these bypasses will be sealed with concrete plugs.

Dikes thrown across the river force the water into the tunnels. The two dikes, one upstream and one downstream, will form the enclosure in which two cofferdams will be constructed to protect the excavation for the foundation of the dam. The upstream cofferdam will be 75 ft. high, the downstream cofferdam 35 ft. The excavation will be about 240 ft. deep.

At the time of the diversion the river flow was about 7,000 sec.-ft.; the tunnels are designed to carry 60,000 sec.-feet.

Evening Courses in Welding Offered in New York City

A series of lectures on the fundamentals of welding will be offered this winter by the Brooklyn Polytechnic Institute in cooperation with the New York section of the American Welding Society. The course will consist of ten lectures covering the following subjects: Characteristics of the welding arc and welding flame, metallurgy and metallography of the welding of steel, physical properties of welds, welding in engineering and building construction, weld inspection and supervision, the welding of alloy steels and non-ferrous metals, the economics of welding, and the selection of the welding process.

The first lecture will be open to anyone interested in welding, and the entire series will be free to members of the American Welding Society. Information may be had from American Welding Society, 33 West 39th St., New York City.

Washington Highlights

by Paul Wooton

Schools for apprentice training are being started by a number of industries. Labor unions are not expected to object as long as acute shortages of skilled labor continue.

The money for the recently announced PWA housing project at Lackawanna, N. Y., comes from the old (NIRA) public works fund which had been earmarked for projects now abandoned. While it is possible that more such recissions in old PWA funds may make it possible to finance one or more additional projects of this type, there is no prospect of such action in the immediate future.

The Great Plains Drought Area Committee will hold public hearings in Delhart, Texas, on Nov. 18 and 19, and in Bismarck, N.D., on November 23, for the purpose of receiving first-hand reports and recommendations leading to the formulation of a long-term drought relief program. The committee expects to receive comments on the general recommendations outlined in its preliminary report of Aug. 27. A series of hearings will also be held in Washington after the committee's visit to the West. The Committee is still at work analyzing a large volume of drought data collected from many governmental and other sources.

So much obsolete machinery is being kept in service by American industry that revision of the theoretical industrial capacity for statistical purposes is being considered by government agencies. Federal statisticians would not be surprised to learn, for instance, that the steel industry really is operating at present at close to 90 per cent of its capacity. It is very much doubted that the industry as equipped at present is capable of increasing its output by 25 or 30 per cent. Incidentally, the steel industry is employing more personnel than in 1929. Many industries, it is stated in official quarters, are at the point where they must make provision for increased capacity if they are to meet demands.

No renewal is expected of the Ways and Means Committee's suggestion that there be an arbitrary reduction of 25 per cent in the amount of depreciation allowed by the Bureau of Internal Revenue. By requiring the taxpayers to submit their own schedules of depreciation and by insisting upon actual records of machinery use, tax collections will be increased about $85,000,000, which is said to be more than would have been collected had the allowances been reduced arbitrarily as the Ways and Means Committee wanted. When deductions for machinery depreciation were checked up closely, they were found to be too liberal. Depreciation was based in many instances on a much shorter period than the machinery actually was in use.

Serious difficulties have been encountered by the Corps of Engineers in the preparation of plans and preliminary studies for flood control projects due to a shortage of skilled personnel, such as draftsmen, computers, and surveyors, on the relief rolls. The funds available for this work are largely relief funds subject to the requirement that 90 per cent of the forces be drawn from relief rolls. Fortunately a small proportion of the money was obtained not

subject to this restriction on the use of it.

It has been possible to carry on certain studies, including the investigation, surveying, and preliminary boring on dam sites in the Connecticut Valley, similar work in upstate New York (carried on principally by CCC labor), hydrologic studies and borings in the Pittsburgh area, and smaller flood control investigations scattered throughout the country.

Formal appropriation of funds by Congress will be necessary before construction of the flood control works, already authorized by the Flood Control Act of 1936, can get under way.

Although it is not yet possible to determine the exact mileage of lines which will be constructed under the sponsorship of the Rural Electrification Administration during 1936, an estimate of 8,000 miles will be very close to the final answer. This figure refers to lines completed and energized. Although allotments so far approved already cover 32,000 miles, the bulk of this construction will extend beyond the end of the current year. Projects approved during the latter part of 1935 are also included in this estimate, since none of these was completed until 1936. The cost of the work averages about $1,000 per mile, with cost figures for projects now under way ranging from $740 to $2,160 per mile.

Except for small advances to cover administration costs, REA does not ordinarily pay any money to the local project management until the completion and acceptance of the line. For this reason the amount actually expended by REA, as of Oct. 10, was only $2,725,000, although approved allocations totaled $35,578,000 on Oct. 30.

Boca Dam Contract Awarded

Contract was awarded on Oct. 27 for construction of Boca Dam in California on the Truckee River storage project of the Bureau of Reclamation to the George W. Condon Co. of Omaha, Neb. on its bid of $729,435. Actual delivery of the contract for construction of Boca Dam will await execution of a repayment contract and of the Truckee River Agreement, which covers the division and use of the waters to be impounded, between the United States and the Truckee-Carson Irrigation District. It is expected that these agreements will be completed in the near future.

Boca Dam will be constructed on the Little Truckee River in California at its confluence with the Truckee River to conserve its waters for use in the Truckee Meadows area of Nevada. The dam will be constructed of a moistened and rolled embankment of clay, sand and gravel. It will be 1650 ft. long at the crest and about 110 ft. high. A concrete lined tunnel will be driven under the right abutment. This tunnel will be used to divert the river during construction and to house the outlet works when the dam is completed. A 3-ft. layer of rock riprap will cover part of the upstream slope. The spillway in the left abutment of the dam will be a concrete lined open channel terminating in a concrete lined stilling basin, and will have a total length of about 555 ft. It will be controlled by two radial gates each of which will be 19 ft. long and 16 ft. wide.

The contract calls for completion in 800 days. It includes 870,000 cu. yd. of earth fill and 115,000 cu. yd. of rock fill. The reservoir will have a capacity of about 45,000 acre-feet.

Educators Reply to President's Letter

Several more answers have been made to President Roosevelt's letter to presidents of engineering schools (*ENR*, Oct. 29, 1936, p. 626), which expressed a wish that the training of engineers might better prepare them to meet their social responsibility to find means to lessen the impact of scientific advance upon society.

All of the replies echoed the statement of Dr. Compton of M.I.T. that attention is now being given to the points mentioned by the President. In particular, a statement prepared by the executive committee of the American Engineering Council and transmitted through Dr. A. A. Potter, president of the Council and dean of engineering at Purdue University, stated that the "engineering educators of the country are fully appreciative of the responsibility of the engineer in bringing about a better balance between technological progress and social control . . . The engineering programs of study are endeavoring to enhance the services of the engineer to the public by more thorough scientific and technological preparation and by special attention to studies which stress social trends, economic problems and good government."

Similarly, a reply sent by H. T. Hammond, president of the Society for the Promotion of Engineering Education, stated that "there has been a clearly discernible trend toward the broadening and enrichment of engineering curricula with greater emphasis upon economics and the social sciences as well as upon scientific and technological fundamentals, rather than upon technical specialties . . . Your letter conveys the impression that engineering educators are not duly or sufficiently conscious of the broad social implications of their work. Such, I believe, is not the case . . . Teachers of engineering aim, without sacrificing the inherent values of the discipline of the professional education, to orient their students toward the social significance of these advancements, as well as to train them in the technique of their accomplishments."

Dr. Williams, president of Lehigh University, expressed the belief that "our failure to enjoy social and economic progress commensurate with technological advances does not lie in the defects of engineering education so much as in the political spoilage of the economic instrumentalities which engineers and other industrialists have from time to time set up." In a statement amplifying this letter, Dr. Williams explained that by his references to economic and social agencies he meant holding companies and employees' associations.

Dr. Williams further expressed the belief that many of the recent governmental reports to which the President referred in his letter were prepared in such a manner as to make their conclusions unreliable and that in particular the pamphlet "Little Waters" which the President sent with his letter, had "poetry, art, facts, and fancy so engagingly commingled as even to increase the obligation of scientific colleges to adhere to fundamentals and critical standards."

SOCIETY CALENDAR

INTERNATIONAL ACETYLENE ASSOCIATION, annual convention, St. Louis, Mo. Nov. 18-20.

ASSOCIATED GENERAL CONTRACTORS, fall meeting of governing board, Washington, D. C., November 16-17.

HIGHWAY RESEARCH BOARD of the NATIONAL RESEARCH COUNCIL, annual meeting, Washington, D. C., Nov. 18-20.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, San Francisco, Calif., December 7-10.

ASSOCIATION OF WESTERN STATE ENGINEERS, annual meeting, Santa Fe, N. M., Dec. 3-5.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, MIDDLE ATLANTIC SECTION, fall meeting, New York City, Dec. 5.

LICENSE EXAMINATIONS

NEW YORK STATE, examination for professional engineers and surveyors, Jan. 25-27, at Albany, Buffalo, New York City and Syracuse. Applications must be filed with the State Education Department at Albany before Nov. 1.

General Hoffman Dies

Brig.-Gen. George M. Hoffman, who retired in 1934 from his position as division engineer of the North Atlantic Division, died on Nov. 1 in Upper Montclair, N.J., at the age of 66.

General Hoffman graduated from the United States Military Academy in 1896. During the World War he commanded the 11th Engineers at the time of the Cambrai offensive, going from there to the First Corps as chief engineer from January, 1918, to January, 1919. From January to May, 1919, he was chief engineer of the First Army, A.E.F., in France. For his services during the World War, General Hoffman was awarded the Distinguished Service Medal.

Served on Panama Canal

During the construction of the Panama Canal General Hoffman served as assistant division engineer of the Atlantic Division, supervising the construction of Gatun Dam from 1907 to 1913. For many years he was connected with the improvement of the Mississippi River as district engineer at New Orleans, La., Vicksburg, Miss., and Louisville, Ky., as a member of the Mississippi River Commission, and as division engineer of the Gulf of Mexico Division.

General Hoffman's most recent service was in New York City. In 1928 he became district engineer of the First New York District and, in October, 1931, he became division engineer of the North Atlantic Division.

PWA Again Rejects Bids On A Housing Project

All the bids received for construction of the superstructure of Lincoln Gardens, the PWA slum clearance and low-rent housing project in Evansville, Ind., were rejected by Administrator Harold L. Ickes. The rejection was made after Director H. A. Gray of the Housing Division had reported that, if the contracts were to be executed at the prices asked in the bids, the dwelling units could not rent for prices within the reach of low income families.

Brief News

TAPPEN DAM, a part of the $34,000,000 Muskingum conservation and flood control project, has been completed. The dam, which creates a 2315-acre lake, is 9 miles southeast of Dennison, in Harrison county, Ohio. Charles Mill Dam, in Asland county, was finished a month ago.

INSTALLATION OF GENERATING EQUIPMENT at the Wheeler dam of the Tennesse Valley Authority, located 15½ miles above Muscles Shoals, has progressed so far that a test run is being given the first 45,000 hp. generator. Water in the reservoir behind the dam has reached a level only 15 ft. below normal pool elevation, giving 6 ft. navigation through the locks.

THE GALLIPOLIS LOCK AND DAM in the Ohio River at Hogsett, near Huntington, W. Va., was placed in use Oct. 29. With the opening of the Gallipolis dam, the federal project for deepening of Kanawha River and construction of four new and higher dams is nearly completed. The Winfield dam on the lower Kanawha was placed in commission several days ago.

REHABILITATION of the 15-mile stretch of the Florida Keys devastated by the hurricane of a year ago has been completed by the Federal Emergency Relief Administration. The Administration built 29 concrete houses and 12 frame houses and repaired 28 others. The concrete structures are believed to be hurricane proof. Roads in the storm zone were also rebuilt.

THE NEW BUILDING CODE for the city of Spokane, Wash., has been passed by the city council and will become effective on Nov. 13. The code was prepared by a building code committee appointed by the city council and headed by A. G. Hoefer, city building inspector. Other members of the committee were Roland M. Vantyne, Charles P. Brant, Henry Georg, Harry J. MacCamy, and Harry F. Aumack.

A TIMBER ENGINEERING COMPANY is to be set up in the South under the auspices of the National Lumber Manufacturers Association and the American Forest Products Industries. Objectives of the new organization will be to encourage the greater use of wood in the construction of oil well derricks, to promote the use of wood in prefabricated houses and to promote the development and use of fireproof and termite-proof lumbers.

THE COST AND FEASIBILITY of a tunnel under the Mobile River at Mobile, Ala. is being investigated by the Alabama state highway department. The investigation is intended to determine the value of the present toll bridge, now the principal means of entry to Mobile, with the possibility that the bridge owners and the state could arrange a plan to free the bridge. The suggested tunnel would provide a route into Mobile six miles shorter than the present route via the toll bridge.

THREE MILLION HOUSES have been built in England and Wales since the World War, according to an announcement made on June 16 by the Minister of Health. Since the total number of pre-war houses in existence is about 7,500,000, this represents an increase of nearly 50 per cent in 17 years. Nearly half the new houses were built in the last five years. In the six months ending March 31, 174,609 houses were built, the largest number ever built in any six months' period.

A CONTRACTOR MAY RECOVER the cost of special equipment purchased for the job as well as the cost of work completed on a cancelled contract, according to a decision of the Oregon Supreme Court. The case involved H. F. Dickson and the Willamette Construction Co. who sued R. H. Emmerson and V. H. Rickert in Platsop county in connection with a contract for hauling logs. The Supreme Court opinion upheld a ruling of the Platsop county court, which held for the plaintiff.

THE MISSOURI SUPREME COURT recently upheld the validity of a statute permitting the organization, through incorporation, of public water supply districts in counties having a population of 25,000 or more. The act, passed in 1935, was designed to permit the formation of such districts in the suburban areas of Jackson and Clay counties adjacent to Kansas City. The test case came up from Clay County, where a taxpayer sought an injunction against the issuance of $410,000 in bonds by Public Water Supply District No. 1.

SURVEYS HAVE BEEN COMPLETED for the new branch line of the Canadian National Railways between Senneterre, on the C.N.R. transcontinental line, and Rouen. (*ENR*, July 16, 1936, p. 100). Construction is expected to start at an early date. This line forms part of a line which the Canadian Pacific Railway had sought permission to construct from the Quebec legislature. Action on the C.P.R. proposal was prevented by the fall of the Taschereau government, and meanwhile the C.N.R. had obtained permission to construct the line from the federal Parliament.

OFFICIAL DENIALS have been made by the Mexican government of recently circulated reports that construction has been suspended on the $3,950,000 dam on the San Juan River in the state of Tamaulipas. Officials state that the work is progressing according to the original schedule. The San Juan River dam is one of several large irrigation projects now being built by the Mexican government. It will irrigate about 600,000 acres of land along the Mexican portion of the valleys of the San Juan and Rio Grande Rivers. Four other irrigation projects, on the Llera, El Cojo, the Xicontentatl, and the Rio Mante are also included in the state of Tamaulipas program. In the state of Coahuila, a single project is under way on the Rio Salado.

Personals

W. P. DAY, engineer and architect, has been elected vice president of the Golden Gate International Exposition in charge of construction on the 1939 San Francisco World's Fair.

W. J. JOHNSTON, formerly on the staff of the district engineer of the Dominion Public Works Department, at St. John, N. B., has been transferred to Winnipeg, Manitoba, as senior assistant engineer for the district.

JAMES H. CISSEL has returned to his position at the University of Michigan as professor of structural engineering after a three-year leave of absence. During that time Professor Cissel was engineer of bridge design for the Michigan state highway department.

H. ALDEN FOSTER has joined the engineering staff of the New York World's Fair Corp. For the past two years Mr. Foster has been resident hydraulic engineer on the Sutherland project of the Platte Valley Public Power & Irrigation District.

HARRISON W. FITZGERALD, who has been assistant Chief engineer on the construction of the Lackawanna, N. Y., strip mill for the Bethlehem Steel Co., has accepted a position as assistant chief engineer of the Corrigan-McKinney Steel Co., Cleveland, Ohio.

SUMNER MARGETTS, Salt Lake City consulting engineer, has been appointed director of the Utah State Planning Board. Mr. Margetts has practiced in Utah and Idaho for the past 16 years, specializing in waterworks, sewer and irrigation problems.

FRED A. SALMON, assistant engineer for the Alabama state highway department, has resigned to accept a position with the West Construction Co. and the Simplicity System Co. of Chattanooga, Tenn.

It was incorrectly stated in *ENR*, Sept. 10, 1936, p. 389, that Mr. Salmon had taken a position with the Tennessee Tractor Co.

CAPT. WILLIAM W. BESSELL, Corps of Engineers, who has been resident engineer for the construction of Bolivar dam of the Muskingum River flood control project in Ohio, has been transferred to the American Battle Monuments Commission, Washington, D. C. After a short period in the Washington office, Captain Bessell will take up duties in connection with construction and maintenance of battle monuments in Europe, with offices in Paris.

Obituary

CALEB N. MOODY, 74, for many years a building contractor in Portsmouth, Ohio, died at Hinton W. Va., on October 24.

EDWARD M. WHEELER, 66, a railway contractor and formerly road supervisor of Jefferson county, Ala., died in Birmingham on Oct. 16. He took part in the construction of the Florida East Coast

Railroad and also contracted for a large portion of the double tracking work on the Louisville & Nashville Railroad.

J. W. WILSON, 63, a construction engineer who had built many state buildings in Oklahoma died recently in Tulsa, Okla.

HENRY B. REED, 69, a retired civil engineer, died on Oct. 17 in Canton, Ohio. Mr. Reed was at one time a member of the consulting firm of Frease & Reed, making preliminary surveys for the Baltimore & Ohio Railroad. Later he was chief engineer for the New York City firm of Ryan & McDonald on construction of the Baltimore tunnel, East River tunnels, New York subways, and Jerome Park reservoir. He retired in 1919.

JAMES W. LAWLOR, of the contracting firm of Lawlor-Woodward, Seattle, Wash., died on Oct. 14 at the age of 47. Mr. Lawlor was connected with the construction of the Spokane-Portland & Seattle Railroad, the Milwaukee, the Great Northern, and the Northern Pacific Railroads. He supervised construction for the Reclamation Bureau on the Kittitas project, built the Owyhee dam in southeastern Oregon, and built the first unit of the Caspar-Alcova project in Wyoming.

CORNELIUS J. GAFFNEY, an engineer for the New York City Board of Transportation died on November 25 in New York City at the age of 61. After his graduation in 1897 from the Sheffield Scientific School of Yale University, Mr. Gaffney worked for the Metropolitan Street Railway, New York City. In 1900 he joined the Rapid Transit Commission's engineering staff, and later worked for the Public Service Commission and the State Transit Commission.

THOMAS J. HILER, a sewer contractor of New York City and Boston and vice-president of the Hiler Engineering Co., died in Brooklyn, N. Y., on October 18. From 1908 to 1920 Mr. Hiler was superintendent of the Brooklyn Ash Removal Co. and the Boston Development Co., a subsidiary of the Brooklyn concern. From 1920 to 1922 he was in business as a sewer contractor, and since that time he had been active in the manufacture of incinerators.

CONSTRUCTION STATISTICS FOR THE WEEK

ENGINEERING construction awards, representing a short week due to Election Day, total $30,071,000 of which private is $7,233,000; public, $22,838,000; federal, $3,285,000; state and municipal, $19,553,000. Corresponding figures for a full week a year ago are: total, $32,691,000; private, $3,716,000; public, $28,975,000; federal, $2,099,000; and state and municipal, $26,876,000.

Highways and public buildings show big drops for the short week. The classified totals are: industrial buildings, $3,571,000; commercial buildings, $3,391,000; public buildings, $2,507,000; highways, $4,032,000; bridges, $3,741,000; sewerage, $1,379,000; waterworks, $579,000; earthwork, drainage, $1,994,000; unclassified, $8,877,000.

The larger awards include: addition to hot rolled sheet mill, Tennessee Coal, Iron and Railroad Co., Birmingham, Ala., $1,125,000; highways, Missouri, $806,000; bridges and roadway, Monroe County, three sections Overseas Highways across Florida Keys, Overseas Road and Toll Bridge District, Miami, Fla., $525,000; underpass, Massachusetts and Commonwealth Avenues, Boston, Mass., $550,000; dredging Sections 4 and 5, Chesapeake and Delaware Canal, U.S. Engineer, Delaware and Maryland, $1,347,000; dredging Jones Neck off James River near Hopewell, U.S. Engineer, Virginia, $519,000; subway, Section 9, Route 10, New York, N.Y., $7,935,000.

New capital for the week includes $4,407,000 in state and municipal bond sales and PWA allotment totalling $17,132,000.

CONTRACTS
(Thousands of Dollars)

	Weekly Average Nov. 1935	Prev. 4 Weeks	Week Nov. 5 1936
Federal Government	$3,797	$3,842	$3,285
State and Municipal	28,871	22,860	19,553
Total public	$32,668	$26,702	$22,838
Total private	6,075	14,066	7,233
Week's total	$38,743	$40,768	$30,071
Cumulative to date: 1935	$1,232,363,000	1936	$1,987,872

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

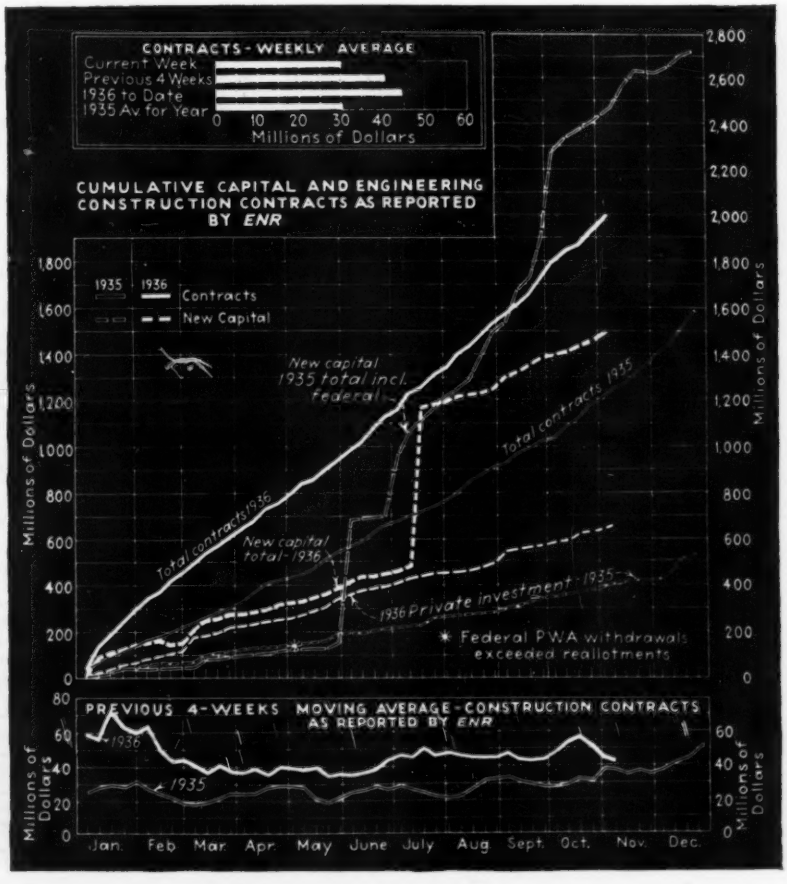
1936	Week Nov. 5	Cumulative
State and municipal	$4,407	$433,345
PWA non-federal	17,132	136,528
RFC loans	....	26,663
Corporate issues	....	210,138
PWA loans, Private	....	—1,665*
Total Non-Federal	$21,539	$805,009
Federal	....	691,237
Federal	....	....
Total new capital	$21,539	$1,496,246
Cumulative to date: 1935	$2,466,279,000	1936 $1,496,246,000

* Bond sales in this classification exceed reallotments during current year.

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities. RFC direct purchase of bonds for "self liquidating" projects, and 25 per cent of WPA construction appropriations.

INDEX NUMBER

EN Cost	1913 = 100	1926 = 100	EN Volume	1913 = 100	1926 = 100
Nov., 1936	212.70	102.24	Oct., 1936	178	78
Oct., 1936	211.50	101.67	Sept., 1936	200	88
Nov., 1935	194.90	93.69	Oct., 1935	162	71
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1936 to Date
1935 Av for Year
0 10 20 30 40 50 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1935 1936
Contracts
New Capital
New capital 1935 total incl. federal
Total contracts 1935
Total contracts 1936
New capital total-1936
1936 Private investment-1935
* Federal PWA withdrawals exceeded reallotments
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1936
1935
Jan. Feb Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

BUSINESS SIDE OF CONSTRUCTION

October 21 Per Cent Over 1935 Cost Index Rises to 212.70

ENGINEERING CONSTRUCTION awards total $220,142,000 for the five weeks recorded in October. Of this total, $75,647,000 is private and $144,495,000 public. Federal awards dropped to $21,628,000. Corresponding values for last year are: total $182,631,000; private, $60,282,000; public, $122,349,000; federal, $32,811,000.

The volume index for October is 178 compared with 162 last year, a gain of only 10 per cent. This index corrects for rising costs and measures physical volume of activity rather than dollar volume.

Public buildings and commercial buildings were not so active in October as in September but public buildings show a 15 per cent gain over 1935 and commercial buildings a 108 per cent gain. Highways approximated the September volume and gained 7 per cent over a year ago. Industrial buildings gained slightly over both September and last year.

Geographically, gains over October are shown in south, middle west, west of Mississippi and far west. Middle Atlantic dropped back to the $15,000,000 per week rate from the September record high. New England maintained the September rate. Except in the far west all territories show gains over last year.

New Capital

New capital for October totals $93,071,000 of which PWA net gain in outstanding allotments is $32,869,000, state and municipal bond sales, $51,662,000 and corporate security issues, $8,540,000.

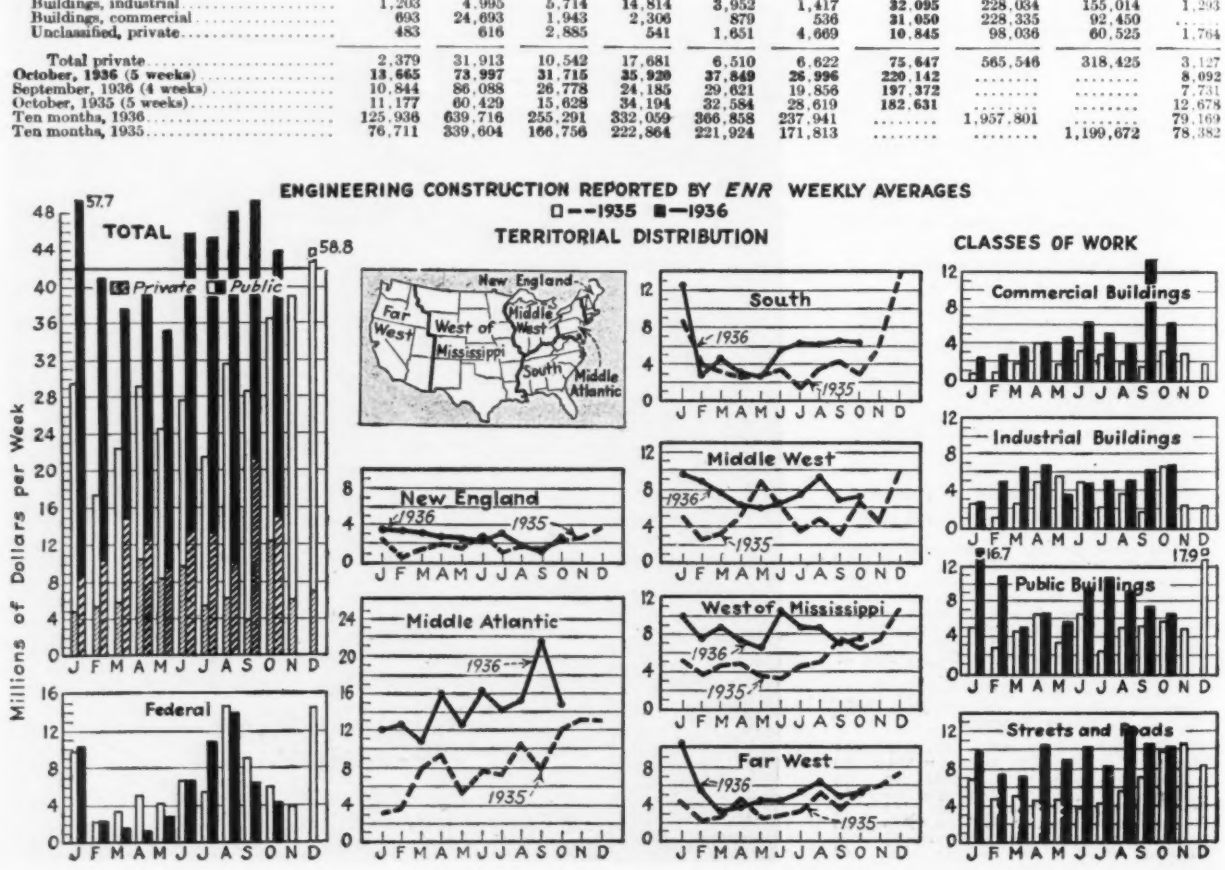
Materials

Portland Cement—Production for September is reported at 12,292,000 bbl. by U. S. Bureau of Mines, shipments, 12,564,000 bbl., stocks, 18,648,000 bbl. Production and shipments in September gained 71.4 and 61.1 per cent over last year. Stocks at mills were 14.4 per cent lower than a year ago. The ratio of production to capacity is 57.1 for September and 56.2 for August compared with 32.6 for September, 1935.

Steel—The average operating rate of steel companies having 98 per cent of steel capacity of the industry who report to American Iron and Steel Institute is 75.0 for October compared with an average of 75.2 a month ago and 50.9 a year ago. The rate

ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN OCTOBER, 1936
Five Weeks — Thousands of Dollars — (000 Omitted)

Public Works	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States October 1936	United States Ten Months 1936	United States Ten Months 1935	Canada October 1936
Waterworks	378	90	206	236	1,119	629	2,748	81,734	59,062	280
Sewerage	118	3,453	1,662	1,489	960	245	7,927	102,995	57,440	87
Bridges, public	4,980	4,217	1,404	840	1,363	1,289	14,093	145,974	59,466	235
Earthwork and waterways	342	743	1,017	4,825	6,029	1,371	14,327	155,646	200,715	255
Streets and roads	2,804	10,820	11,587	7,291	11,660	7,818	51,980	420,358	250,173	2,662
Buildings, public	699	9,980	4,142	2,538	8,694	6,811	32,864	390,476	206,677	370
Unclassified, public	1,965	12,781	1,065	1,020	1,514	2,211	20,556	95,072	47,714	1,076
Total public	11,286	42,084	21,173	18,239	31,339	20,874	144,495	1,392,255	881,247	4,965
Federal government (included in above classifications)	301	4,641	4,167	1,813	8,449	2,257	21,628	275,516	288,137	.....
Private										
Bridges, private	.....	1,609	.....	20	28	.....	1,657	11,141	10,436	70
Buildings, industrial	1,203	4,995	5,714	14,814	3,952	1,417	32,095	228,034	155,014	1,293
Buildings, commercial	693	24,693	1,943	2,306	879	536	31,050	228,335	92,450	.....
Unclassified, private	483	616	2,885	541	1,651	4,669	10,845	98,036	60,525	1,764
Total private	2,379	31,913	10,542	17,681	6,510	6,622	75,647	565,546	318,425	3,127
October, 1936 (5 weeks)	13,665	73,997	31,715	35,920	37,849	26,996	220,142	.....	.....	8,092
September, 1936 (4 weeks)	10,844	86,088	26,778	24,185	29,621	19,856	197,372	.....	.....	7,731
October, 1935 (5 weeks)	11,177	60,429	15,628	34,194	32,584	28,619	182,631	.....	.....	12,678
Ten months, 1936	125,936	639,716	255,291	332,059	366,858	237,941	.....	1,957,801	.....	79,169
Ten months, 1935	76,711	339,604	166,756	222,864	221,924	171,813	.....	.....	1,199,672	78,382

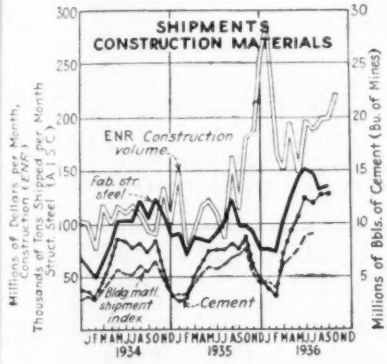


dropped from 75.9 in the second week of October to 74.3 in the final week.

A slight improvement in the bookings and shipments of fabricated structural steel during September was shown in the final tabulation of the American Institute of Steel Construction. This reverses the normal trend as between August and September. The total of business done by this industry during the first nine months of 1936 was in excess of the business done during the whole twelve months of 1935.

Contracts closed in September amounted to 48.1 per cent of normal. Shipments in September amounted to 58.6 per cent of normal. Last year for the same months the contrasting averages were 38.5 per cent and 41.7 per cent.

Lumber—Lumber production, reported to the National Lumber Manufacturers Association, averaged 69 per cent of the 1929 weekly average. Shipments averaged 71 per cent of the 1929 average and reached 275,000,000 feet on the high week.


SHIPMENTS
CONSTRUCTION MATERIALS
ENR Construction volume
Fab. str. steel
Bldg. matl. shipment index
Cement
Millions of Dollars per Month, Construction (ENR) and Thousands of Net Tons per Month Struct. Steel (A.I.S.C.)
Millions of Bbls. of Cement (Bu. of Mines)
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1934
1935
1936

Building Permits

Sharp gains in a few large cities in the Middle Atlantic, South Atlantic and East Central sections lifted the September total of building permit values for 215 cities 6.6 per cent above the August total. The usual change for the period is a decrease of close to 10 per cent. The volume of permits issued in these 215 cities of the United States during September reached the sum of $88,791,762, compared with $83,109,753 in August, and $47,479,944 in September, 1935, according to Dun & Bradstreet, Inc. The increase over September last year is 87.0 per cent. Permits issued in the five boroughs of New York City totalled $17,331,441, compared with $12,095,174 in August and $9,227,037 in September, 1935, increases, respectively, of 43.3 and 87.8 per cent. In 214 other cities permit values for September aggregated $71,460,321, a gain of 0.6 per cent over the $71,014,579 figure for August, and a rise of 86.8 per cent compared with 1935.

Labor

Employment in private building construction in September, 1936 was 23.2 per cent above the corresponding month of last year and pay rolls were 36.6 per cent greater than in September, 1935. The reports supplied to the Bureau of Labor Statistics, U. S. Department of Labor, by 8,758 contractors in September, 1936 covered 107,965 employees engaged in erecting, altering, and repairing private buildings.

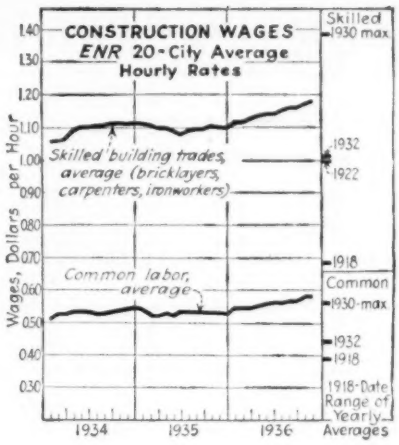
During September, more than 3,200,000 wage earners were employed on projects financed by the works program. Of this total, 2,586,000 were working on projects operated by the Works Progress Administration. Compared with August employment, this is an increase of approximately 100,000. The increase occurred on that part of the program operated by the Works Progress Administration and was accounted for wholly by additional employees in the drought area.

Employment on all Public Works Administration projects was moderately lower in September. During the month approximately 333,000 workers were employed on these projects compared with 343,000 working in August. Of the 333,000 workers reported under Public Works Administration, 196,000 were engaged on projects financed from E.R.A.A. 1935 funds and are therefore also reported above under the works program.

In emergency conservation work (Civilian Conservation Corps) a decrease of 63,000 in the number of workers employed was reported for September. The drop in employment was largely in enrolled personnel and was due to the end of an enlistment period. Of the 321,000 workers engaged on this program in September, 270,000 were enrolled employees; 41,000, supervisory and technical workers; 8,000, reserve officers; and 2,000, educational advisers.

The number of employees working on construction projects financed from regular governmental appropriations increased slightly in September. This program engaged 150,000 workers in September compared with 147,000 in August.

In August, general building contractors in New York State continued to add to their forces and increase pay rolls and man-hours. Percentage increases over July amounted to 9.8 per cent in employment, 17.0 per cent in pay rolls and 14.0 per cent in man-hours. Decreases in employment,



payrolls and hours were reported by firms engaged in foundation contracting. Residential builders employed fewer workers in August than in July but increased pay rolls and man-hours. Firms engaged in non-specialized building and commercial building increased employment, pay rolls and hours. Highway contractors reported an increase in employment of 6.6 per cent.

A general construction wage increase on January 1 is anticipated in St. Louis. Sheet metal workers raised from $1.25 to $1.37½ in July anticipate a further increase to $1.50 in January, carpenters expect to go from $1.25 to $1.50, asbestos workers from $10 to $11 a day, iron workers from $1.47 to $1.75. The Building Trades Council estimated that 95 per cent of the 15,000 members of various unions are now steadily employed, the best record since 1929.

Bricklayers on the federal government low-cost housing project at Kenfield, N. Y., are being paid $12 a day or $2 more than the union scale in an effort to complete outside construction by January 1.

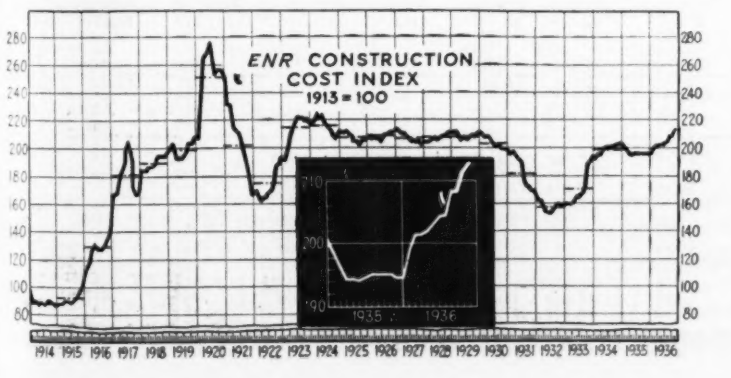
ENR Cost and Volume Index

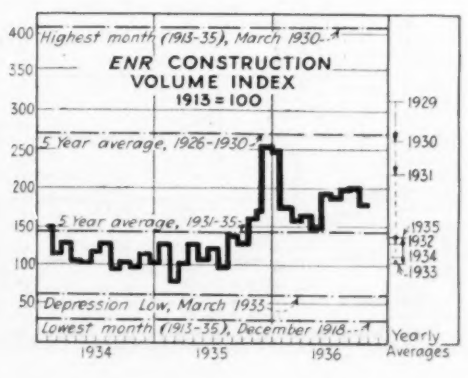
THE *Engineering News-Record* Construction Cost Index rises to 212.70 for November due to an increase in lumber.

The *ENR* Volume Index is 178 for October.

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
Nov., 1936	**212.70**	**102.24**	**Oct., 1936**	**178**	**78**
Oct., 1936	211.50	101.67	Sept., 1936	200	88
Nov., 1935	194.90	93.69	Oct., 1935	162	71
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47





CURRENT PRICES OF CONSTRUCTION MATERIALS

CEMENT, AGGREGATES AND READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT (Per bbl., carload lots, including 40c. per bbl. for bags, cash discount not included)			SAND AND GRAVEL (Per ton, carload lots)			CRUSHED STONE (Per ton, carload lots)		CRUSHED SLAG (Per ton, carload lots, f.o.b. plant)		CONCRETE (Ready-Mixed 1:2:4, 5000 p.s.i. or more, delivered)
	Cloth Bags*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.83	$2.58	$2.50	$1.60	$1.60	$1.55	$1.69	$1.92	$1.69	$1.69	$8.50
Baltimore	2.66	2.41	2.21	1.80‡	1.80‡	1.30‡	1.80‡	1.80‡	1.80	1.80	7.35
Birmingham	2.40	2.15	1.95	1.80	1.80	1.45	1.00	1.00	.90	1.15	5.45
Boston	2.42	2.12	1.92	1.40	1.40	.90	1.40	1.40	.....	.....	6.50
Chicago	2.50	2.25	2.10	1.50	1.50	1.50	1.80	1.80	1.00	1.00	.....
Cincinnati	2.50	2.25	2.05	1.20	1.20	1.30	1.80	1.80	.....	.....	6.70
Cleveland	2.46	2.21	.....	1.40	1.40	1.45	1.60	1.60	1.75	1.75	7.85z
Dallas	2.45	2.20	2.00	1.55	1.55	1.30	1.95	2.05	.....	.....	7.00
Denver	3.09	2.84	.....	1.20	1.40	.90	.....	.....	.....	.....	.....
Detroit	2.25	2.00	1.80	1.30	1.30	1.20	1.50	1.75	1.40‡	1.50‡	5.95
Kansas City	2.51	2.26	2.06	1.85	1.85	1.15	1.85	1.80	.....	.....	7.65
Los Angeles	2.32	2.12	.....	1.20	1.20	.90	1.20	1.20	.....	.....	6.31
Minneapolis	2.80	.....	2.35	1.00p	1.00p	.25p	1.00p	1.00p	.....	.....	7.00d
Montreal	.....	.....	1.70	.80	.85	1.00	1.20‡	1.30‡p	.....	.....	6.50f
New Orleans	2.50	2.30	2.05	1.50	1.50	1.25	.....	.....	.....	.....	8.35
New York	2.70‡	2.45‡	.....	1.20†k	1.20†k	.70†k	1.75†k	1.85†k	.....	.....	8.00
Philadelphia	2.68	2.43	2.23	1.45‡	1.55‡	1.15‡	2.60‡	2.75‡	1.00‡	1.00‡	8.00D
Pittsburgh	2.46	2.21	1.61	1.50‡	1.50‡	1.70‡	2.25‡	2.25‡	1.50	1.50	7.00
St. Louis	2.53	2.28	.....	1.60‡	1.40‡	1.25/1.40‡	.75p	.75p	.65/.95§	.50/.95§	6.95
San Francisco	2.72	2.52	2.20	1.35	1.35	1.35	1.50	1.50	.....	.....	7.53
Seattle	2.95	2.70	.....	1.00	1.00	1.00	1.44	1.44	.....	.....	6.75

*10c. allowed for each returnable bag. †Per cu. yd. ‡Delivered. §F.o.b. Granite City, Ill. kBarge lots alongside dock. pf.o.b. plant. f5 tons or more. pWithin 3-mi. from Pub. Square. fton. d 5% discount for cash. D Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Alpena, Mich	$1.50	$1.45	Ironton, Ohio	$1.50	$1.45	North Birmingham, Ala	$1.75	$1.70
Buffington, Ind	1.70	1.65	Iola, Kans	1.70	1.65	Richard City, Tenn	1.85	1.80
Crestmore, Calif	1.72	.....	La Salle, Ill	1.70	1.65	Saginaw, Mich	1.40	1.35
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.70	1.65	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.70	1.65	Mason City, Ia	1.70	1.65	Universal, Pa	1.65	1.60
Hudson, N. Y	1.75	1.70	Norfolk, Va	1.76	1.71	Waco, Tex. (Plus 5c. Tax in Texas)	1.75	1.70
Independence, Kans	1.70	1.65	Northampton, Pa	1.65	1.60	Wyandotte, Mich	1.45	1.40

Cash Discounts, Cement, to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount, 10c. per bbl. for payment within 15 days of date of invoice.

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE—PARTITION—SCORED (Per M, lots of 2,000 pieces or over)			STRUCTURAL CLAY TILE—LOAD BEARING—SCORED (Per M, lots of 2,000 pieces or over)			BRICK (Per M, in quantity)		LIME		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Per ton, Hydrated finishing	in paper, Common hydrated	carload lot Pulverized or lump
Atlanta	$71.10	$75.80	$142.10	$170.50	$199.00	$227.40	$12.25	$14.25	$19.50	$14.00	$14.00
Baltimore	91.00	98.00	183.00	219.00	315.00	390.00	13.00	17.00	20.00	14.00	25.00
Birmingham	78.75	84.00	157.50	189.00	201.25	242.00	15.00	19.00	3.00§	1.75§	2.25§*
Boston	79.90,i	85.20,i	159.75,i	181.05,i	237.30,i	271.20,	14.50	18.00	20.00	15.50	3.50a
Chicago	66.00	70.40	132.00	174.30	214.40	245.00	10.20	11.20	18.00	13.40	14.00
Cincinnati	58.85	62.80	117.75	141.30	169.26	209.56	17.50	17.50	15.97	12.48	.....
Cleveland	45.00	48.00	90.00	108.00	138.50	158.50	15.00	15.00	16.00k	14.00k	2.65k,
Dallas	68.00	67.00	140.00	160.00	190.00	260.00	13.50	24.00	19.00	16.00	1.55p
Denver	78.50	88.00	141.50	166.50	196.00	225.00	11.50	15.00	30.00k	22.00k	22.50k
Detroit	71.85	76.65	143.70	230.00	280.00	325.00	12.50	13.50	18.00	15.00	15.25
Kansas City	64.50	66.50	81.00*	125.50	159.75	186.25	13.00	22.00	18.90	12.40	10.35
Los Angeles	77.50	94.25	134.00*	188.00	232.50	311.50	11.50	14.00	18.70	.....	19.70
Minneapolis	80.15a	85.50a	145.40a	167.75a	175.25a	243.70a	13.10	15.10x	25.50	21.00	23.00
Montreal	84.00a	96.00a	180.00a	273.00	.....	.....	15.50	20.75	25.50	17.00	11.00
New Orleans	69.00	69.00	129.00	155.05	203.25	251.70a	13.00	.....	18.40	11.25	.....
New York	78.40	83.60	125.40*	193.30†	238.80†	295.60†	12.50	.....	20.00	15.50	20.00
Philadelphia	86.00	90.00	150.00	200.00	240.00	280.00	18.00	20.00	16.35	11.25	10.75
Pittsburgh	58.40c	62.30c	116.85c	165.00c	217.00c	250.00c	16.50	25.00	17.20	14.50	2.22p
St. Louis	62.00	65.00	120.00	180.00	234.00	280.00	15.00	18.00	22.00	16.00	2.00r
San Francisco	84.00	94.50	225.00	.....	.....	.....	15.00	18.00	.55§	.40§	2.05r
Seattle	84.00	95.00	180.00	198.00	.....	.....	15.50d	18.50	30.00	20.00	28.60r

6x12x12 in. †F.o.b. Perth Amboy, N. J. ‡Per sack. §Per bbl., 200 lbs. pPer bbl. 180 lbs. gper bbl. 280-lb. kLCL. dless $1 cash 15 days. *lump. sSmooth. xSelected common. fCarload lots delivered to job.

ROAD SURFACING MATERIALS—F.O.B. CITY

	PAVING BRICK AND BLOCKS			PAVING ASPHALT		ASPHALT BINDERS—FLUXES		CUTBACK ASPHALT		ROAD OILS		ASPHALT EMULSION	
	Granite per M. lots of 50,000, 4x4x8 in.,	Brick per M., 3x4x8½ in., carload lots	Wood per sq.yd., 3½ in., 16-lb. treat,	Per ton, less than 80 penetration, Tank car	Drums	Per gal., 80-300 penetration, Tank car	Drums	Per ton, Tank car	Drums	Per gal., Tank car	Per gal., Tank car	Drums
Atlanta	$ 75.00	$35.00	$2.25	$17.40z	$ 2.62z	$0.0687z	$0.100z	$18.15z	$26.20z	$0.687z	$0.0875	$0.0875
Baltimore	108.00	44.00	2.25	17.00	22.00	.075	.10	.09†	.125†	.....	.....	.....
Birmingham	110.00	25.00	.....	19.00	24.00	.0878	.1128	.10†	.137†	.....	.06	.....
Boston	75.00	24.00	2.75	17.00	22.00	.07e	.095e	.09†e	.12†e	.07e	.095e	.125e
Chicago	125.00	42.00	1.985	16.00	20.00	15.00	19.00	.07	.11	.045	.09	.135
Cincinnati	115.00	37.00	.....	13.47	17.47	.12	.....	17.00	.....	.055	.08	.....
Cleveland	100.00‡	32.50	2.85	17.50	21.20	.075	.094	.085	.055†	.0575	.085	.095
Dallas	.....	30.00	.....	18.00	21.75	.065	.16	18.75	26.25	.055	.085	.11/.135
Detroit	.....	37.00	.....	16.80*	21.00*	.....	.....	15.25	20.25	.055	.11	.15
Kansas City	.....	40.50	.....	18.50	23.50	17.50#	22.50#	.077†	.107†	.057	.11	.15
Los Angeles	.....	50.00	.....	10.34	14.50	10.34#	14.50#	10.34	.....	.042	.06	.12
Minneapolis	.....	.....	1.75l	18.20	24.70	.098	.098	21.85	34.65	.048	.....	.....
Montreal	85.00	60.00	3.62	14.00	20.00	.10	.13	.0975†	.1175†	.0675	.135	.165
New Orleans	100.00	32.00	.....	15.20	18.75	.068	.095	.075†	.10†	.....	.0785	.11
New York	120.00§	65.00	2.75	17.00	22.00	.075	.10	.09†	.125†	.....	.075	.11
Philadelphia	110.00	45.00	2.25	13.50	18.00	.05	.08	.05†	.08†	.045	.08	.....
Pittsburgh	115.00	40.00	.....	19.00	24.00	.0775	.1125	.086†	.121†	.0675	.....	.....
St. Louis	115/120	35.00	.....	19.70	24.70	.08775	.1075	.0825†	.1125†	.045	.09	.12
San Francisco	.....	50.00	.....	12.00	18.00	12.00#	18.00#	12.50#	23.00#	.04	.0575	.117
Seattle	.....	35.00	.....	25.50	25.50	17.00#	23.00#	15.00	.....	.03	.19	.20

Note: Paving asphalt, tank car or boat, f.o.b. Maurer, N. J., per ton, Bermudes, $25.00; Trinidad, $21.00. *Per sq. yd. †Per gallon. ‡4½x6x5½in. #per ton §4x5x9-in. Av. xMexican. zLocal reduction due to 20% reduction intra-state class freight rates, only Georgia affected. l 2½ in. 6 to 8-lb. treatment. e F.o.b. Everett

CURRENT PRICES OF CONSTRUCTION MATERIALS

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¼-in. billet,	RIVETS ½-in. structural	WIRE NAILS Base	SHEET PILING Base	STEEL RAILS Per Gross Ton Standard	Light	Re-rolled	TRACK SUPPLIES Angle bars	Std. spikes	Tie plates	Track bolts
Birmingham	$2.05	$2.10	$3.15	$2.55	.....	$36.375	$35.00	$34.00	$2.55	$2.75	$2.00	$3.75
Chicago	1.95	2.10	3.15	.....	$2.35	36.375	35.00	34.00	2.55	2.75	2.00	3.75
Pittsburgh	1.90	2.05	3.05	2.05	2.25	36.375	35.00	34.00	2.55	2.75	2.00	3.75

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

F.O.B. WAREHOUSE	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ¼ in., base price New billet	Rail steel	EXPANDED METAL LATH Per 100 sq.yd., carload lots Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING Per 100 s.f., carload lots 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in., No. 6 & 6 wires Per sq.yd.	SHEET PILING Per 100 lb. base price
Atlanta	$3.36	$2.34	$2.19	$21.00	$23.00	$1.58	$1.20	$0.1494	$2.70
Baltimore	3.00	2.75	2.60	24.00	26.00	1.45	1.11	.1368	2.45
Boston	3.74	3.10	2.062	22.00†	24.00†	1.51	1.15	.1422	2.67
Chicago	3.30	2.10	1.95	20.00	22.00	1.44	1.11	.1359	2.35
Cincinnati	3.40	3.25	3.25	25.01	29.50	1.43	1.10	.1350	.....
Cleveland	3.31	2.75	2.60	20.00	22.00	1.42	1.09	.1332	.....
Dallas	3.45x	2.825x	2.675x	22.00	28.00	1.69	1.27	.1593	3.005
Denver	4.05	3.76	3.61	22.00	25.00	1.70	1.27	.1611	.....
Detroit	3.52	2.20	2.05	20.00†	22.00†	1.45	1.11	.1368	2.53
Kansas City	3.85	2.75	2.60	19.00	21.00	1.55	1.18	.1467	2.79
Los Angeles	2.35	2.45	.....	23.00	27.50	1.72	1.29	.1629	2.65
Minneapolis	3.55	2.86	2.71	22.00	26.00	1.54	1.17	.1458	2.67§
Montreal	3.25	2.15	2.15	32.50	35.50	2.46	1.82	.253	2.30
New Orleans	.....	.....	.....	20.75	23.75	1.59	1.20	.1503	.....
New York	3.47	2.50	2.35	17.50	19.50	1.48	1.13	.1395	2.60
Philadelphia	3.10	3.06	2.22	20.00	24.00	1.46	1.12	.1377	2.56
Pittsburgh	1.90‡	1.85‡	1.90‡	20.00‡	22.00‡	1.38	1.07	.1296	2.25
St. Louis	3.55	2.45	2.30	22.00	25.00	1.45	1.11	.1368	2.30
San Francisco	3.50	2.475	2.325	23.00	28.00	1.72	1.29	.1629	2.60
Seattle	3.55	2.50	.....	24.50	26.50	1.72	1.29	.1629	2.60

‡Base Mill Price. Note: Shapes, bars and piling subject to quantity discounts. §Mill Price plus freight to Minneapolis. †f.o.b. delivered. xf.o.b. Houston

PAINTING AND ROOFING SUPPLIES—F.O.B.

	RED LEAD Per 100 lb. in 500-lb. lots Dry	WHITE LEAD Per 100 lb. in 500-lb. lots# in oil	READY-MIXED PAINT Per gal., drums Graphite*	Aluminum†	Ferric Oxide‡	ROOFING SUPPLIES Carload lots, f.o.b. factory Rolls, slate surfaced, 85-90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating, per gal.	Tar pitch, 350 lb. bbl., per ton
Atlanta	$7.75	$11.00	$1.60	$2.50	$1.40	$1.94	$1.70	$1.70	$.36	$25.60
Baltimore	7.00	10.50	1.45	2.25	1.70	2.03	3.00	3.00	.35	25.00
Birmingham	7.25	11.00	2.35	2.35	1.85	2.01	1.77	1.77	.36	22.00
Boston	7.00	10.50	1.80	2.60	.0475x	1.75	3.10	3.10	.42	20.00
Chicago	7.00	10.50	1.35	.....	.....	2.47	2.23	2.24	.32	33.00
Cincinnati	7.00	10.50	1.45	2.50	1.40	2.40	2.30k	2.30k	.36	21.00
Cleveland	7.00	10.50	1.70	2.45	1.40	1.55	1.75k	1.75k	.23	19.00
Dallas	7.25	11.50	1.80	2.10	.....	2.35k	3.80	3.80	.14	35.00
Denver	7.50	11.25	2.55	.....	.....	2.25	3.55	3.55	.35	30.00
Detroit	7.00	10.50	1.65	2.30	1.40	2.50	2.65	2.50	.35	30.00
Kansas City	7.00	10.62½	1.65	2.65	1.10	1.78	3.15	3.15	.25	24.50
Los Angeles	7.25	10.75	1.60	2.25	2.30	2.00	1.50	.....	.45	.....
Minneapolis	7.00	10.62½	.....	.....	.....	1.75v	1.62½v	1.62½v	.29	23.80
Montreal	.....	8.20	2.00	4.75	2.40	2.50	1.60	1.83	.50	1.52§
New York	7.00	10.50	1.75	2.35	1.50	1.75	1.62k	1.62k	.232	22.00
Philadelphia	7.00	10.50	2.50	2.95	1.50	1.68	1.86k	1.48k	.37	22.00
Pittsburgh	7.00	10.50	1.05	1.95	.80	1.75	1.65k	1.65	.38	25.00
St. Louis	10.00	10.50	1.85	2.45	1.30	1.83k	2.57	2.57	.25	25.00
San Francisco	7.25	10.75	1.80	2.75	1.10–2.00	1.89	3.10	3.10	.38	26.00
Seattle	7.25	10.75	1.80	2.85	2.20	3.30	2.66	2.60	.60	30.00

*U. S. War Dept. Spec. 3-49A. †ASTM Spec. D266-31. ‡80% maximum ferric oxide. §Per 100 lb. kPer roll, 65 lb. xPer lb. v Minneapolis & vicinity
Note: Red lead in oil 50c higher than white lead in oil. #Basis of quoting changed this month from list to 500-lb. lots.

MISCELLANEOUS ITEMS

	WINDOW GLASS Discounts from latest jobbers List, Sept. 15, 1928 Single or Double Thickness A quality	B quality	EXPLOSIVES Per lb. dynamite delivered 50-lb. cases Gelatin 40%	60%
Atlanta	80%	80%	$0.135	$0.15
Baltimore	88%	90%	.145	.16
Birmingham	88%	90%	.095	.11
Boston	88–10–5%	90–10–5%	.13	.145
Chicago	87%	88%	.105e	.12c
Cincinnati	89–10%	91–10%	.27	.29
Cleveland	85%	85%	.215	.225
Dallas	87%	89%	.1350	.1500
Denver	88%	90%	.145	.16
Detroit	87–10%	89–10%	.204	.235
Kansas City	85–10%	86–10%	.35	.15
Los Angeles	90%*	90–40%	.1725†	.1925†
Minneapolis	86%	87%	.145	.16
Montreal	60–30%	70–5%	.18	.1925
New Orleans	88%	90%	.215	.23
New York	89%	90%	.215x	.23x
Philadelphia	89%	90%	.13	.1450
Pittsburgh	88%	88%	.10	.115
St. Louis	89%	89%	.13	.145
San Francisco	80%	85%	.1475	.1625
Seattle	90–10%	90–20%	.1425	.1575

*Disc. from list Aug. 1, 1929. †F.o.b. Arsenal. ‡Double thickness A & B. xManhattan only – other Boroughs $6 per trip. c carload lots

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York.	
Bleaching powder, in drums, F.o.b. works, per 100-lb.	$2.00–2.25
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalized with points of competition, per ton	22.00–35.00
Chlorine cylinders, per lb. delivered	.055
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb.	1.35
Soda ash, 58%, in paper bags, per 100 lb. dense	1.25
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	27.00–30.00
Sulphate of copper, in bbl., per 100-lb.	4.00

PILES

Prices per linear foot, pine, with bark on, f.c.b. New York; delivered from barge 1½ to 2c, per ft. additional:

Dimensions	Points	Length	Short Leaf— Barge	Rail	Long Leaf— Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.16	$0.195	$0.16	$0.19
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.20	.24	.18	.23
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21	.255	.19	.24½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.23	.265	.23½	.27½
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.25	.275	.27½	.33½
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.32	.415	.....	.....
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.35	.482	.....	.....

RAILWAY TIES

Prices f.o.b., per tie, for carload lots:		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Boston	Oak, untreated	$1.00	$1.40
	Pine, untreated	1.10	1.45
	Pine, creosoted	1.55	2.10
New York	Long-leaf sap pine, untreated	1.05	1.25
	Mixed oak, untreated	1.20	1.40
	White oak, untreated	.85	1.35
Birmingham	Red oak, creosoted	1.50	1.70
	Southern pine, untreated *6x8x8'6"	.55*	.70
	Southern pine, creosoted	1.10*	1.30
Chicago	White oak, untreated	1.15	1.40
	Oak, empty cell, creosoted	1.50	1.88
	Oak, zinc treated	1.40	1.70
	Southern pine, creosoted	1.35	1.78
Los Angeles	Fir, untreated	.50	.72
	Fir, creosoted	1.67	2.40
Philadelphia	Red oak, untreated	1.00	.....
	Red oak, creosoted	.....	2.10
St. Louis	White oak, untreated	1.05	1.45
	Red oak, untreated	1.02	1.40
	Red oak, creosoted	1.55	1.95
	Sap Pine or cypress, untreated	.87	1.20
San Francisco	Douglas fir, green, untreated	.45	.63
	Douglas fir, empty cell, creosoted	1.14	1.56
Montreal	Birch or maple, untreated	.65	.75
	Birch or maple, creosoted	1.05	1.35

CURRENT PRICES OF CONSTRUCTION MATERIALS

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE	VITRIFIED SEWER PIPE				CLAY DRAIN TILE		CONCRETE SEWER PIPE		WROUGHT STEEL PIPE			
	Per net ton, f.o.b. 6 in. to 24 in.*	Per foot, delivered, ASTM C 13-35 8 in., s.s.	12 in., s.s.	24 in., d.s.	36 in., d.s.	Per 1,000 ft., carload lots, f.o.b. 6 in.	8 in.	Per ft., delivered; ASTM C 14-35 12 in.	24 in.	Full standard weight. # 1 to 3 in., Butt Weld Black %	Galv. %	3½ to 6 in., Lap Weld Black %	Galv. %
Atlanta	$43.00	$0.25dl	$0.45dl	$1.625l	$4.50l	$85.00	$128.00	$0.45	$1.625	49.5	40.5	47	37.5
Baltimore	46.50	.28	.54	2.38	7.18	110.00	170.00	.40	1.60				
Birmingham	39.00	.25	.45	1.625	4.66	85.00	220.00	.40	1.60	69.5	61.5	67	58.5
Boston	46.50	.224	.432	1.98	5.845	99.00	153.00	.42	2.35				
Chicago	47.50	.245	.4725	2.025	4.60	60.00	120.00	.36	1.42	59.75	48.75	55.625	45
Cincinnati	46.00	.189	.3645	1.62	5.535	69.00	108.00	.40	1.40	58.75	48.75	55.625	45.00
Cleveland	47.50	.168	.324	1.44	4.1225	42.50	88.50	.32	1.64	61	51	57.9	47.25
Dallas	51.00	.35	.67	2.70	.....	165.00	260.00	.46	1.57	69.5	61.5	67	58.5
Denver	59.00	.27‡	.47‡	1.98‡	.....	105.00	180.00	.....	.....	50	40	47	36
Detroit	47.50	.203	.3915	1.71	5.2375	82.00	136.00	.35	1.20	59.3	49.3	56.1	45.5
Kansas City	49.00	.30	.54	2.16	5.00	120.00	140.00	.40	1.50	55	45	51.5	41
Los Angeles	47.50	.2825‡	.5085‡	2.03‡	5.535‡	115.50	192.50	1.00	2.00	62.1	54.1	59.6	51.1
Minneapolis	49.50	.24‡	.432‡	1.728‡	4.60‡	.....	.....	.65	1.75	.....	.....	.....	.....
Montreal	50.00	.33c‡	.59c‡	2.04c‡	.....	82.00	134.00	.51	2.04	.....	.....	.....	.....
New Orleans	45.00	.23	.41	1.60	.....	67.00	.....	.47	1.67	.....	.....	.....	.....
New York	46.00	.26	.51	2.25	6.15	.....	.....	.55	2.00	57.50¤	47.50¤	54.375¤	43.75¤
Philadelphia	43.00	.336	.648	2.835	8.68	175.00	210.00	.54	1.80	52.37¤	41.37¤	53.39¤	42.37¤
Pittsburgh	49.00	.182‡	.351‡	1.62‡	4.92‡	69.00	108.00	.75c	1.75	69.5	61.5	67	58.5
St. Louis	46.00	.25	.45	1.83	3.96	85.00	170.00	.80	2.00	57.125	47.125	54	43.375
San Francisco	47.00	.209L	.522L	2.088L	5.67L	103.50	172.50	.45	2.20	53.69	47	50	39
Seattle	48.50	.4225	.63†	3.06†	7.55†	85.00	200.00†	.50†	1.80	65.80	57.25	66.75	56.30

*b. & s. class B and heavier, C/L lots, 200 tons and over. Burlington, N. J. (base) $43.00. Gas pipe and class A, $3 per ton additional, 4-in., $3 per ton additional. 30 in. and larger usually $2 per ton less.

#Discounts from standard list for delivery from warehouse, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¼ in., 8½c; ⅜ in., 11½c.; ½ in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92.

¤2½ to 3 in. •Resale price to consumer, car load lots shipped from mill.

‡f.o.b. †Less 30% in C/L Lots. c Concrete Culvert pipe reinforced. dDouble strength. ‖List to dealers. L list. tSales & municipal taxes extra.

LUMBER AND TIMBER—PER M FT. B.M., CARLOAD LOTS F.O.B.

		SHORT LEAF YELLOW PINE AND DOUGLAS FIR								LONG LEAF Y. P.	
		All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft.								Merchantable grade up to 20 ft.	
		1x6,§	1x8,§	2x4,§	2x6,§	2x8,§	2x10,§	3x12,#	6x12,#	12x12,#	2x12,#	12x12,#
Atlanta	Southern Pine	$16.50	$16.50	$16.50	$18.50	$18.50	$20.00	$24.00	.....	.....	$38.50	$38.50
Baltimore	Southern Pine	23.50	24.50	27.50	26.50	27.00	29.00	37.50			55.00	57.00
	Douglas Fir	29.50	29.50	28.50	29.50	28.50	28.50	30.50	$29.00	$29.00	.....	.....
Birmingham	Southern Pine	21.00	21.00	22.00	20.00	21.00	23.00	30.00	30.00	28.00	.....	.....
	Long Leaf	22.00	22.00	25.00	24.00	25.00	28.00	45.00	.....	.....	45.00	45.00
Boston	Rooters N.C. Pine	29.00	29.00	31.00†	33.00†	49.00†	55.00†	73.00†	.....	.....	73.00	73.00
	Douglas Fir	27.00	27.00	29.00	33.00	35.00	35.00	35.00	35.00	35.00	.....	.....
Chicago	Southern Pine	29.00	29.50	33.50	32.50	32.50	35.50	45.50	.....	.....	54.50	54.50
Cincinnati	Southern Pine	25.50	25.50	25.50	24.50	25.50	28.50	39.50	.....	.....	41.00	44.00
	Douglas Fir	.....	.....	.....	.....	.....	.....	43.75	43.75	43.75	.....	.....
Cleveland	Southern Pine	30.00	32.00	38.00	32.00	36.00	38.00	49.00	44.00f	46.00f	52.00	64.00§
Dallas	Southern Pine	d33.75	35.10	38.25	36.00	36.90	33.25	50.85	65.25	59.85	65.29	68.05
Denver	Douglas Fir	42.00	42.00*=	43.00*	43.00*	43.00*	47.00*	52.00*	56.00*	61.50	.....	.....
Detroit	Southern Pine	26.50	26.50	26.50	26.50	26.50	30.50	38.00	.....	.....	32.00	44.00
	Douglas Fir	.....	.....	.....	.....	.....	.....	42.50	42.50	43.00	.....	.....
Kansas City	Southern Pine	25.50	26.00	26.50	25.50	26.50	27.00	35.00	.....	.....	50.00	60.00
	Douglas Fir	27.00	28.00	29.00	28.00	29.00	29.00	33.00	36.00	36.00	.....	.....
Los Angeles	Douglas Fir	32.00„	32.00„	32.00„	32.00„	34.00„	34.00„	36.00„	45.00y	40.00y	.....	.....
Minneapolis c	Western Pine	45.00*	51.50*	50.00*	41.00*	41.00*	42.00*	.....	.....	.....	58.00*▲	.....
	Douglas Fir	42.00*	42.00*	43.00*	43.00*	43.00*	43.00*	55.00*	59.50*	59.50*	54.00	.....
Montreal	Pine	45.00	45.00	49.00	47.00	48.00	58.00	.....	.....	.....	.....	.....
	Douglas Fir	39.50	39.50	40.00	40.00	40.00	41.50	42.00	42.00	42.00	82.00	76.00
New Orleans	Southern Pine	23.50	25.50	28.00	25.00	27.00	25.50	38.00	.....	.....	44.00	54.00
	Douglas Fir	28.50	30.00	33.00	29.00	32.00	33.50	37.00	.....	.....	.....	.....
New York	Southern Pine	34.00*	35.00*	33.00*	35.00*	35.00*	36.00*	45.00*	44.00*	44.00*	77.50*	77.50*
	Douglas Fir	.....	.....	38.00*	38.00*	39.00*	39.00*	40.00*	.....	.....	36.00	42.00
Philadelphia	Southern Pine	30.00	31.00	32.00	32.00	33.00	34.00	36.00	42.00	42.00	.....	.....
	Douglas Fir	45.00	45.00	45.00	45.00	45.00	45.00	45.00	.....	.....	57.50	57.50
Pittsburgh	Southern Pine	30.50	31.90	37.65	35.75	36.52	37.50	47.75	.....	.....	.....	.....
	Douglas Fir	38.52	39.70	39.70	38.55	39.10	39.38	53.25	53.25	53.25	.....	.....
St. Louis	Southern Pine	29.00*x	30.00*x	29.00*x	28.00*x	29.00*x	30.00*x	46.00*x	.....	.....	.....	.....
	Douglas Fir	.....	.....	.....	.....	.....	.....	.....	54.00*x	54.00*x	71.00	70.00
San Francisco	Douglas Fir	20.50t	20.50t	21.00t	21.00t	21.50t	22.50t	22.00t	22.00t	22.00t	.....	.....
Seattle	Douglas Fir	15.50	15.50	15.50	14.50	14.50	14.50	21.00	20.00	20.00	.....	.....

*Delivered. †Spruce. ‡Long-leafed Y. P. §Norway Pine. ▲Northern Pine. =Native. fAt ship's tackle. „Yard prices. a10% Disc. taken off. x5M ft. or less
§S4S. #Rgh. •Contractors in Minneapolis and St. Paul get 15% disc. from list. y Douglas Fir.

CURRENT BUILDING AND CONSTRUCTION WAGE RATES PER HOUR

	Bricklayers	Carpenters	Structural Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$1.125	$0.40/1.00	$1.25	$1.00/1.50	$1.00	$0.30/.40	$0.30/.40
Baltimore	1.25	1.10	1.37½	1.25	1.25	.45	.45
Birmingham	1.00	1.00	1.25	1.125	1.00	.30/.40†	.30/.40†
Boston	1.30	.70/1.175	1.20	.90/1.425	1.375	.50/.625	.50/.70
Cincinnati	.80/1.375	.65/1.20	1.25	1.00/1.25	.80/1.375	.45	.45
Chicago	1.50	1.50	1.50	1.50	1.50	.95	.95
Cleveland	1.375	1.25	1.25	1.25	1.375	.82	.82
Dallas	.65/1.00	.65/1.00	.65/1.00	.65/1.00	.65/1.00	.35/.50	.35/.50
Denver	1.25	1.25	1.25	.....	.....	.625	.625
Detroit	1.25	1.00	1.25	1.25	1.25	.50/.75	.60
Kansas City	1.325	1.25	1.25	1.25	1.425	.80	.45/.50
Los Angeles	1.10	1.10	1.125	1.125	1.25	.60	.60
Minneapolis	1.25	1.00/1.10	1.00/1.25	1.00/1.25	1.35	.60/.75	.60/.75
New Orleans	1.00	.75	1.00	1.00	1.25	.30/.40	.30/.40
New York	1.50	1.40	1.65	1.50/1.5625	1.50	.82½	.50/.80
Philadelphia	.35/1.50	.65/1.10	.70/1.375	.90/1.00	1.10/1.37	.35/50	.40/.50
Pittsburgh	1.50	1.25	1.375	1.00	1.50	.70	.50
St. Louis	1.50	1.25	1.47	1.57/1.75	1.50	.78¾	.35/.78¾
San Francisco	1.50	1.125	1.37½	1.12½	1.50	.875	.60
Seattle	1.00	1.00	1.25	1.25	1.25	.60	.60
Monteral	.70	.60	.80	.55	.70	.35	.40

Skilled Avg.: (Bricklayers, Carpenters, Ironworkers) $1.178 Common Avg. $0.583 † PWA.